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Family Annualized Cost of Leaving: The Household as the Decision Unit in Military Retention

Paul F. Hogan
Systems Research and Applications Corporation

May 1990

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for the Behavioral and Social Sciences

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This research supports the Army Family Action Plans (1984-1989) by developing a Family Annualized Cost of Leaving model that describes the costs and benefits associated with retention. Although approximately 55% of Army members are married and roughly half of the nonmember spouses work in the marketplace, models of Army reenlistment behavior such as the Annualized Cost of Leaving (ACOL) model have typically focused on individual members as decisionmakers. Focus on the individual service member omits important family factors affecting retention decisions.

A model of Army reenlistment behavior with the family or household as the focal point in the decision process was developed. Army families are assumed to reenlist or leave to enter the civilian sector based on the market earnings opportunities of the service member and the market earnings and the value of nonmarket activities for the spouse. In particular, the cost to the Army family imposed by certain aspects of military life, such as Permanent Change of Station (PCS), on the earnings opportunities of the nonmember spouse was estimated.

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19. ABSTRACT (Continued)

This measure, along with other factors, was entered into a reenlistment equation.

The notion of labor market rent, or consumer surplus, was developed to measure the potential loss to the family. Some spouses choose to work in the marketplace while others work in nonmarket home production activities. Both of these activities are valued by the household. Hence, differences in the spouse's market earnings because of military life may be a misleading indicator of differences in welfare. Calculation of the difference in spouse labor market rent, rather than earnings, ensures that nonmarket activities of spouses are not valued at zero.

The loss in spouse labor market rent was estimated from a three equation model of spouse labor supply behavior using data from the 1985 DoD Member and Spouse Survey. The effect of frequent moves and other factors of military life on the spouse's wage is estimated from a spouse wage equation corrected for self-selection bias. The expected wage, based upon spouse characteristics, was included in the labor supply equation, which is estimated as a two-limit tobit model.

A measure of the loss in spouse labor market rents was calculated from the three equation model of labor supply and included in the family reenlistment equation. The reenlistment equation is estimated from a sample of Army male enlisted members from the 1985 DoD Survey.

From the wage equation, it was found that a 1-month increase in the average time that a spouse spends at a given location in a year is associated with a 1% increase in the wage. From the labor supply equation, it was found that a 10% increase in the spouse wage is associated with a 12% increase in weeks worked, for those spouses already working, and about a 5% increase overall. A working nonmember spouse loses approximately 10 weeks of work, other things being equal, if the family makes a PCS move during the year.

The regression results from the reenlistment equation provide evidence generally consistent with the family model of reenlistment behavior. The estimated parameters imply that a $100 decline in the loss of spouse rents will increase the probability of reenlistment by about 3%. This implies a reenlistment rate elasticity of about -.12 with respect to the loss in rent. In contrast, a $100 increase in the member's Army pay will increase the probability of reenlistment by about 1%, suggesting a reenlistment elasticity with respect to member's pay of about 1.3.

A simulation of this system of equations suggests that a 12-month increase in the average tour length, reducing PCS move frequency by about 24%, would result in an increase in spouse wages of about 6% on average. The resulting decline in the loss of spouse labor market rent will increase the probability of reenlistment by about 3%, on average.

The family ACOL model explains more fully the costs and benefits associated with retention for married Army personnel. It provides a more precise estimate of the effects of traditional variables included in the retention equation and reduces the possibility of biased estimates on these traditional variables. This model will aid in policy formulation by providing a direct quantitative link between measurable factors affecting the family, particularly factors affecting family income through nonmember spouse employment, and the decision to remain in the Army.

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Family Annualized Cost of Leaving: The Household as the Decision Unit in Military Retention

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May 1990

The Army Family Research Program (AFRP) is a 5-year integrated research program started in November 1986 in response to research mandated by the CSA White Paper, 1983: The Army Family and subsequently by The Army Family Action Plans (1984-1989). The objective of the research is to support the Army Family Action Plans through research products that will (1) determine the demographic characteristics of Army families, (2) identify positive motivators and negative detractors to soldiers remaining in the Army, (3) develop pilot programs to improve family adaptation to Army life, and (4) increase operational readiness.

The research is being conducted by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) with assistance from Research Triangle Institute, Caliber Associates, HumRRO, and Systems Research and Applications Corporation. It is funded by Army research and development funds set aside for this purpose under Management Decision Package (1U6S).

This report describes the development of a Family Annualized Cost of Leaving model, a natural extension of the Annualized Cost of Leaving (ACOL) model that has been applied to the individual's retention decision. This family ACOL model explains more fully the costs and benefits associated with the retention decision for married Army personnel, provides a more precise estimate of the effects of traditional variables included in the retention equation, and reduces the possibility of biased estimates of these traditional variables. The model will aid in policy formulation by providing a direct quantitative link between measurable factors affecting the family, particularly factors affecting family income through nonmember spouse employment, and the decision to remain in the Army. The sponsor of this research, the U.S. Army Community and Family Support Center (CFSC), reviewed this report. Their comments indicate that the contents of this report will be useful in revising Army programs and policies.

EDGAR M. JOHNSON
Technical Director

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FAMILY ANNUALIZED COST OF LEAVING (ACOL): THE HOUSEHOLD AS THE DECISION UNIT IN MILITARY RETENTION

EXECUTIVE SUMMARY

Requirement:

To support the Army Family Action Plans (1984-1989) by developing a Family Annualized Cost of Leaving model that describes the costs and benefits associated with the retention decision. Even though approximately 55% of Army enlisted members are married, and roughly half of the nonmember spouses work in the marketplace, models of Army reenlistment behavior, such as the Annualized Cost of Leaving (ACOL) model, have typically focused upon the individual member as the decision-making unit. Such a focus on the individual service member omits important family factors affecting decisions to stay or leave military service.

Procedure:

A model of Army reenlistment behavior with the family or household as the focal point in the decision process was developed. Army families are assumed to reenlist or leave to enter the civilian sector based upon the market earnings opportunities of the member and the market earnings and the value of nonmarket activities for the spouse. In particular, the cost to the Army family imposed by certain aspects of military life, such as Permanent Change of Station (PCS) moves, on the earnings opportunities of the nonmember spouse was estimated. This measure, along with other factors, was entered into a reenlistment equation.

The notion of labor market rent, or consumer surplus, was developed to measure the potential loss to the family. Some spouses choose to work in the marketplace while others work in nonmarket home production activities. Both of these activities are valued by the household. Hence, differences in the spouse's market earnings due to the effects of military life may be a misleading indicator of differences in welfare. Calculation of the difference in spouse labor market rent, rather than earnings, ensures that nonmarket activities of spouses are not valued at zero.

The loss in spouse labor market rent was estimated from a three equation model of spouse labor supply behavior using data from the 1985 DoD Member and Spouse Survey. The effect of frequent moves and other factors of military life on the spouse's wage is estimated from a spouse wage equation, corrected for self-selection bias. The expected wage, based upon spouse characteristics, was included in the labor supply equation, estimated as a two-limit tobit model.

A measure of the loss in spouse labor market rents was calculated from the three equation model of labor supply, and included in the family reenlistment equation. The reenlistment equation is estimated from a sample of Army male enlisted members, using reenlistment "intentions" data from the 1985 DoD Survey.

Findings:

From the wage equation, it was found that a 1-month increase in the average time that a spouse spends at a given location in a year is associated with a 1% increase in the wage. From the labor supply equation, it was found that a 10% increase in the spouse wage is associated with a 12% increase in weeks worked, for those spouses already working, and about a 5% increase overall. A working nonmember spouse lost approximately 10 weeks of work, other things being equal, if the family made a PCS move during the year.

The regression results from the reenlistment equation provide evidence generally consistent with the family model of reenlistment behavior. The estimated parameters imply that a $100 decline in the loss of spouse rents will increase the probability of reenlistment by about 3%. This implies a reenlistment rate elasticity of about -.12 with respect to the loss in rent. In contrast, a $100 increase in the member's Army pay will increase the probability of reenlistment by about 1%, suggesting a reenlistment elasticity with respect to member's pay of about 1.3.

A simulation of this system of equations suggests that a 12-month increase in the average tour length, reducing PCS move frequency by about 24%, would result in an increase in spouse wages of about 6% on average. The resulting decline in the loss of spouse labor market rent will increase the probability of reenlistment by about 3%, on average.

Utilization of Findings:

The family ACOL model explains more fully the costs and benefits associated with the retention decision for married Army personnel. It provides a more precise estimate of the effects of traditional variables included in the retention equation and reduces the possibility of biased estimates on these traditional variables. This model will aid in policy formulation by providing a direct quantitative link between measurable factors affecting the family, particularly factors affecting family income through nonmember spouse employment, and the decision to remain in the Army.

FAMILY ANNUALIZED COST OF LEAVING (ACOL): THE HOUSEHOLD AS THE
DECISION UNIT IN MILITARY RETENTION

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FAMILY ANNUALIZED COST OF LEAVING (ACOL): THE HOUSEHOLD AS THE DECISION UNIT IN MILITARY RETENTION

1.0 INTRODUCTION

1.1 Background

The military retention decision is an application of the economic theory of occupational choice, where a selection is made among alternative employment options, or paths of employment, that offer the greatest lifetime utility. Historically, most of the occupational choice literature focuses on the individual.

The theory suggests that individuals choose occupations based on pecuniary and nonpecuniary attributes of each alternative. Attributes include current pay, deferred compensation, hours of work, location, amenities, and physical risk. The individual ranks employment options in terms of expected satisfaction provided by these attributes and behaves accordingly.

In recent years, more attention in the field of labor economics has been given to the family as an economic decisionmaking unit. However, this emphasis has been largely upon the labor supply decision of married women. There have been virtually no analyses of the occupational choices of family members from the perspective of the household, though the labor supply models provide a framework for this analysis.[1]

Household models that rely on the family as the decision unit have developed primarily in response to the increased importance

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[1] An exception to this is Frank (1978) and another is Mincer (1978) who build an economic framework for analyzing the family migration decision. The relevance of this literature for a model of retention behavior from the household perspective is discussed at some length in Section 3, below.

of women in labor markets. Married women are no longer limited to childbearing and household production, but actively engage in market production as well.

Female labor force participation has steadily increased in the past century from 17.4% in 1890 to 66.4% in 1986.[2] Rising real wage rates, changes in household technology, gains by women in college enrollment and experience levels, the feminist movement, equal opportunity legislation, exogenous fertility decreases induced by contraceptive technology, and rising levels of marital instability and divorce rates are among the reasons that have been suggested for the increase in female labor force participation rates.

At the same time, the proportion of families in the military has been increasing. Until 1942, the Army did not permit the peacetime enlistment or reenlistment of men with wives and minor children. After World War II, the Army increased its commitment to the family -- by 1960, family members outnumbered uniformed personnel.

Today, the proportion of married personnel in the Army has leveled off at about 55 percent, up from about 49 percent in 1981[3]. More than 80 percent of the officer corps is married. About 78 percent of the enlisted career force is married, and the

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[2] Statistics on female labor force participation are for ages 20-64 (see Economic Report of the President, transmitted to the Congress January 1987). Historic rates are 17.4% (1890), 19.3% (1900), 22.9% (1920), 25.4% (1930), 29.4% (1940), 33.3% (1950), 42.3% (1960), 50.0% (1970), 60.8% (1980), and 66.4% (1986).

[3] Most of this increase occurred between 1981 and 1983 (Defense Manpower Data Center). Percent of married Army personnel over the past 10 years: 51.99 (1977), 51.82 (1978), 51.59 (1979), 49.98 (1980), 48.85 (1981), 51.83 (1982), 55.63 (1983), 55.26 (1984), 55.29 (1985), 54.89 (1986), 54.71 (1987).

percentage of married first term enlistees recently increased from 28 percent to nearly 35 percent.[4]

Hence, at the same time that females are participating more in the labor force and less in their traditional household roles, families are becoming an increasing proportion of the Army. Within the institutional military setting, these two trends may produce conflict. Inherent characteristics of the military exert hardship on the family that can both keep the service member (usually the husband) from making a satisfactory contribution to household production and the spouse (usually the wife) from working in the labor market.

The demands of a military job, including frequent deployments, often necessitate family separation. While away from family, the service member cannot contribute to household production, such as child care. Absence from home over a period of time may result in an inefficient allocation of resources at a level unacceptable to the family.

Similarly, frequent Permanent Change of Station (PCS) moves required in the military, and the limited and irregular amounts of time the member is able to devote to household production, can impede the ability of the nonmember spouse to find suitable employment. Frequent relocation discourages spouse investment in job search, investment in general human capital by the nonmember spouse, and invest in firm specific human capital by potential employers. In remote or isolated areas, there may be few or no jobs available for spouses of service members. The loss in income from spouse unemployment or from reduced wages becomes an important consideration in the retention decision.

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[4] Department of the Army, "The Army Family." DA PAM 608-41, May 20, 1986.

1.2 Overview of the Research

A focus on the individual service member omits important
family factors affecting decisions to stay or leave the Army. The
development of a family ACOL model, a natural extension of the
Annualized Cost of Leaving (ACOL) model that has been applied to
the individual's retention decision, will more fully explain the
costs and benefits associated with the retention decision, provide
a more precise estimate of the effects of traditional variables
included in the retention equation, and reduce the possibility of
biased estimates of these traditional variables. Finally, it will
aid in policy formulation by providing a direct, quantitative link
between measurable factors affecting the family, particularly
factors affecting family income through nonmember spouse
employment, and the decision to remain in the Army.

The military services have recognized the importance of the
family in retention and readiness. Demands that the military
lifestyle place on the service member and spouse increase levels
of stress and hardship relative to their civilian counterparts.
The Services have reacted to this difficult problem in various
ways. For example, the Army has developed a Family Action Plan to
implement family policies and programs. But despite positive
steps in family policy, there remains relatively little empirical
work derived from a solid theoretical foundation from which to
base policy decisions.

The present effort develops a model of retention behavior
based solidly on economic theory with the family as the focal
point in the decision process. Our purpose is the development and
exposition of a household model of voluntary retention behavior in
the Army. It is intended to be consistent with price theory and
derived from the assumption of utility maximizing behavior.

The notion of labor market rent, or consumer surplus, is
developed. It is a means to combine both the value of leisure, or

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home production time, and labor income into a welfare measure that reflects the net effects of military life on nonmember spouse labor market opportunities. The relationship between this concept and the "Annualized Cost of Leaving" is examined. A three-equation spouse labor market model is developed and estimated. From this system, a numerical estimate of the loss in spouse labor market rents due to military life is calculated.

The measure of spouse labor market rent is entered into a model of reenlistment behavior. Though the household reenlistment model is a simple one, it is sufficient to test the effect of this structural measure of the loss in spouse labor market rent on the reenlistment probability.

The remainder of this section summarizes the major issues addressed in the research effort, highlighting the major results. It follows the structure of the body of the report and may serve as a guide to the reader of the remainder of the report.

1.3 Summary of the Report

Section 1.3.1 reviews the purpose of this research. In section 1.3.2, we outline the major conceptual issues, the derivation of the model, and how this model addresses those issues. Section 1.3.3 offers a synopsis of the three equation spouse labor supply model we use to estimate the effect of military life on the spouse's expected wage and weeks of work. A description of how the labor supply model is used to estimate the expected financial effect of military life on spouse labor market opportunities is described and the empirical results are highlighted. In section 1.3.4, the results from testing our theory of a household or family retention model are presented. Section 1.3.5 discusses the potential policy implications of the research and areas for future research suggested by our results. Section 1.3.6 outlines the remainder of the report.

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1.3.1 Purpose and Scope of the Research Effort

The purpose of this effort is twofold: (1) to develop a solid theoretical framework for incorporating the labor market opportunities of the nonmember spouse into the family's decision to remain in the Army and (2) to test this theory using data from the 1985 DoD Survey of Members and Spouses. This research is, to our knowledge, the first effort to develop a household model of reenlistment behavior that incorporates the effects of spouse labor market opportunities in a rigorous way. Hence, greater emphasis than is typical is placed on the derivation of the model from underlying first principles and on methodology.

Rigorous theoretical development of a household model is important for several of reasons. First, it helps in understanding reenlistment behavior by developing and testing an explicit mechanism by which choices are affected. Second, solid theoretical development helps the researcher avoid the pitfalls of ad hoc empirical specifications. It guides the empirical work, providing a framework or paradigm for interpreting the results. This is especially important in research that may be used for policy because it helps the researcher to distinguish spurious empirical correlations from relationships that may be used in policy development.

Third, it forces one to build and expand upon the existing body of knowledge in a systematic fashion. The relationship between the household model and previous work on reenlistment behavior that focused on the individual is made clear. In our exposition of the household model, for example, we offer a new derivation of the Annualized Cost of Leaving model, the most prominent model of retention behavior in the literature. We show that the Annualized Cost of Leaving model is a special case of our household model. Hence, the new model is placed in the context of

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previous research and, at the same time, new insights are provided on this literature.

Any model, no matter how carefully derived from theory, becomes simply an elegant mental exercise unless its predictions are found to be consistent with actual behavior.[5] Hence, the second task of this effort is to estimate and test the model, once developed. The model estimated is a "quasi reduced form" household reenlistment model. It includes a structural estimate of the loss in spouse labor market opportunities, but includes variables such as the member's civilian opportunities in reduced form. This, again, reflects the overall scope of the research, and its relative emphasis, at this point, on theoretical development. However, this "quasi-reduced form" is sufficiently rich to obtain many of the policy insights that would be available from a full structural model.

1.3.2 Theory

The most prominent model of military retention behavior, the Annualized Cost of Leaving (ACOL) model, constructs the member's financial incentive to stay as proportional to the (annualized) difference between military earnings and earnings in the member's best civilian alternative. The leisure, or home production time, of the member is not explicitly included in the model. Implicitly, it is assumed that the member works the same number of hours in each alternative, so that there is no difference in home production. Hence, one may compare the earnings of the member should he remain in the Army to those he would be offered should he enter the civilian sector. The difference in spouse earnings from remaining in the Army relative to entering the civilian sector, then, is the apparent analogue to the ACOL value of the member.

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[5] As the aphorism notes, "the proof of the pudding is in the eating".

While the implicit assumption of no change in leisure or home production time between the military and civilian sector may be reasonable for the member, it is not for the nonmember spouse. Once we recognize that for the nonmember spouse we may have to compare not only differences in wage rates between sectors, but differences in the amount of time the spouse chooses to allocate to the labor market, it is no longer innocuous to ignore the value of nonmarket time. Consider three extreme cases:

(1) The spouse may be a full time worker whether the family remains in the Army or leaves and enters the civilian sector. This case would be analogous to the assumptions underlying the calculation of the member's ACOL.

(2) Alternatively, the nonmember spouse may choose to allocate all of her time to home production, regardless of whether the family remains in the Army or leaves for the civilian sector. In this instance, any costs that military life may impose upon the nonmember spouse's labor market opportunities are irrelevant, because the value of home production or leisure time of the spouse always exceeds the spouse's wage.

(3) Finally, the spouse may choose not to work in the market if the family remains in the Army, because the effects of aspects of military life, such as routine PCS moves, depresses her wage below the value of time spent in home production. However, if the family were to leave the Army, wage offers to the spouse may be sufficiently high to induce her to work.

The difference in actual, or imputed, earnings would be satisfactory measure of the incentive to leave the Army in case (1). In case (2), any imputed difference in earnings would overstate the incentive to leave because the value of home production or leisure exceeds the value of earnings. In (3), the difference in earnings would again overstate the incentive to leave as it would ignore the value of time spent in home production or leisure.

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More generally, whenever the allocation of time between home production and the market changes, the difference in the value of home production or leisure time as well as the difference in earnings must be considered. The challenge, then, is to develop a measure of the value of the difference in nonmember spouse labor market opportunities that can provide the correct measure in all cases.

The measure we have derived is the expected change in the spouse's producer surplus, or labor market rent. It is the supply analogue to the notion of consumer surplus, and represents the change in the value of labor market earnings opportunities net of the value of leisure or home production time foregone.

Figure 1.1 illustrates the concept. In this diagram, $H(...)$ is the spouse's labor supply curve, indicating how much time she would allocate to the market at a given wage. Note that the wage offer must be above W_O before any time would be supplied to the market. In the diagram, W^A represents the spouse's wage offer while the family remains in the Army. At this wage, she would supply H^A weeks of work to the market. The spouse would enjoy an expected wage rate of W^B should they leave the Army. At this wage, she would supply H^B weeks of work to the market. W^B is expected to be greater than W^A because of the costs imposed on the spouse's labor market opportunities by military life, such as frequent moves. In this instance, the difference in spouse labor market rents is the shaded area equal to (approximately):

$$(W^B-W^A)H^A + .5 \ (W^B-W^A)(H^B-H^A) \qquad (1.1)$$

This is less than the difference in expected earnings, $W^B H^B - W^A H^A$, by the value of the foregone leisure or home production time, H^B-H^A, represented by the area under the supply curve between H^A and H^B.
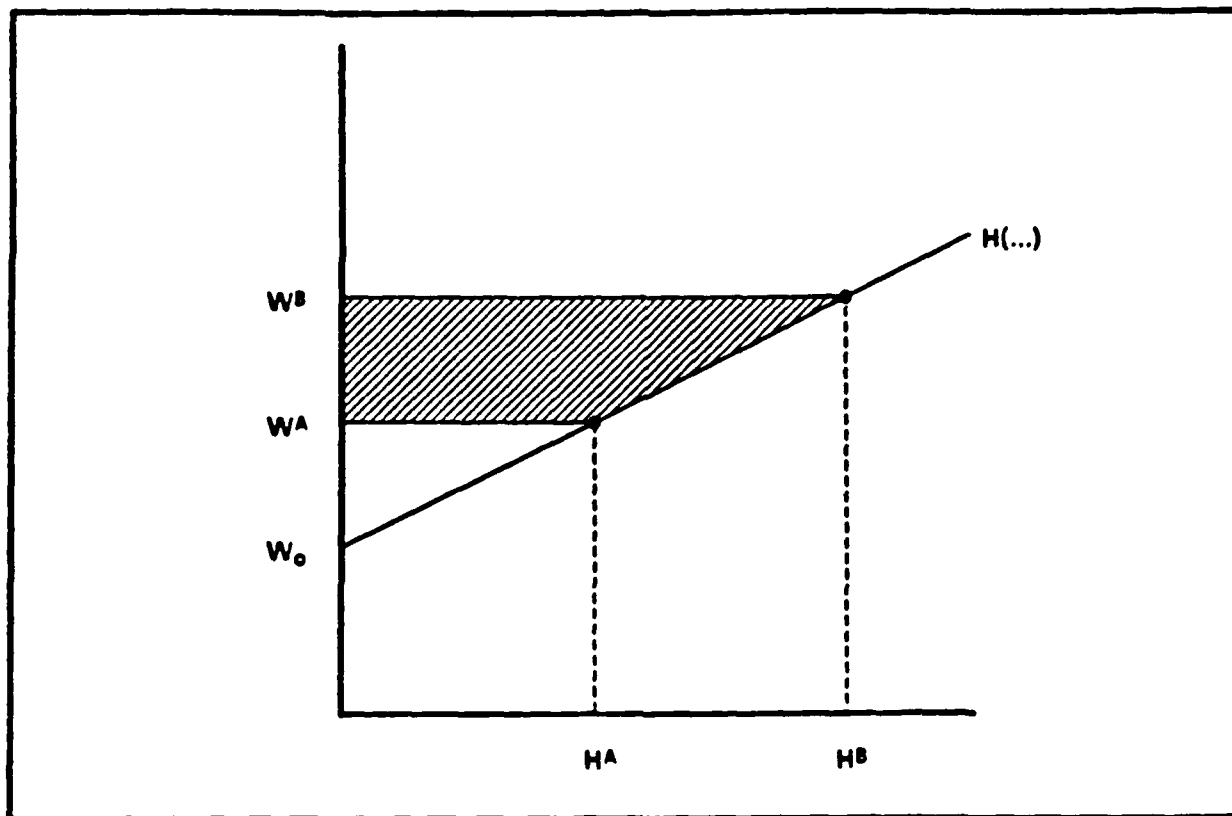
FIGURE 1.1: LOSS IN SPOUSE LABOR MARKET RENTS

Note that if W_A were less than W_O, the reservation wage, such that the nonmember spouse allocated no time to the market while the family was in the Army, the measure of the loss in spouse labor market opportunities would be the triangular area below the wage line defined by W^B but above the supply curve. Once again, the difference in earnings, $W^B H^B - 0$, would overstate the loss. The correct measure is the difference in labor market rent.

Our family or household model of reenlistment behavior is based upon the maximization of household or family utility. It is derived directly from an assumed household utility function. The arguments of this function are the leisure or home production time of each of the two adult members of the household, and the money income of the family. Pecuniary income is increased by trading

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additional hours of leisure or home production time for wage income in the labor market.

The derivation makes use of the indirect utility function, in which both the member's and spouse's market supply curve appear. The key equations for estimating the change in labor market rent from the indirect utility function have a clear interpretation as empirically estimable labor supply curves, as in Figure 1.1. The frequently encountered leap between the model implied by theory and the empirical counterpart that is actually estimated is avoided here.

Finally, our derivation of the family or household model of the reenlistment decision obtains the Annualized Cost of Leaving model for the individual as a special case, and, in fact, represents a new way to view this model.

1.3.3 Spouse Labor Supply Model

A Three Equation System. Our model of family reenlistment behavior implied that the costs imposed by various aspects of military life on spouse labor market opportunities, which we have called the expected loss in labor market rent, can be measured from a structural model of spouse labor supply. We develop a three equation system: (1) an equation describing the nonmember spouse's reservation or shadow wage; (2) an equation for the spouse's market wage; and (3) a labor supply equation relating weeks worked to the spouse wage and other variables.

The first two equations are combined to estimate the probability that the spouse is working. The criterion for working is that $W > R$; that is, the market wage is greater than the reservation wage, R. The reservation wage equation includes, inter alia, variables that affect the value of time spent at home, such as the number of children, and the presence of pre-school age children. The wage equation includes variables that affect the

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spouse's wage opportunities. These include the usual set of human capital variables, such as education and experience. But, also included are variables reflecting the influence of military life on the wage rate, such as the time spent at the current location, and the historical frequency of PCS moves. The probability of employment equation is estimated as a probit.

Next, we estimate the spouse wage equation. Because the wage equation is estimated using data only from those spouses who worked, there is a potential for sample selectivity bias.[6] A transformation of the expected probability of working, calculated from the probit equation, is included as an explanatory variable to reduce the potential for selectivity bias.

Finally, we estimate the labor supply equation. The wage variable in the supply equation is calculated as the expected wage, conditional on spouse characteristics, from the estimated wage equation. The labor supply equation is estimated as a two-limit tobit, with truncation points at zero weeks worked and at 52 weeks. Approximately 48% of the sample did not work at all, while approximately 12% reported working the maximum of 52 weeks per year.

The wage equation is used to estimate the spouse's expected wage if the family were to remain in the Army, and the expected wage offer if the family were to leave military service. The expected loss in labor market rent is then calculated from the tobit supply equation.

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[6] Sample selectivity bias is discussed more fully in the body of the report. Intuitively, the notion is that spouses who worked have different, presumably higher, wage offers on average than those with the same measurable characteristics who did not. If there are some measured characteristics that are correlated with the unmeasured factors affecting the wages of those who work, the estimated effect of the measured factors will be biased. Population inferences based only on the portion of the sample that worked will be biased.

Empirical Results. The system was estimated using spouse
earnings and labor supply data from calendar year 1984 reported
from the 1985 DoD Survey of Members and Spouses. The empirical
results were generally quite good. The major factors
hypothesized to affect the probability of working, the spouse's
wage, and the supply of labor to the market, were generally
statistically significant and consistent with underlying theory.
The major results are summarized below.

Probability of Working. The presence of dependents in the
family, especially pre-school dependents, has the largest negative
effect on the probability that the spouse is working. The factors
that significantly increase the probability of working are the
human capital variables affecting the wage rate: education and
experience. A CONUS location, U.S. citizenship, and a primary
language of English are also associated with a a higher
probability of working. The number of months separated from the
member spouse also was associated with a higher probability of
working, though there are several alternative interpretations for
this result.

Wage Equation. The empirical results suggests that spouses
who are college graduates enjoy a weekly wage that is
approximately 72% higher than non-high school graduates, 52%
higher than high school graduates, and about 38% higher than
spouses with some college, while an additional year of experience
increases the weekly wage by about 5%. There is also a large wage
premium for spouses who are not minorities and for being a U.S.
citizen. Most importantly for our analysis, we find that an
increase of one month in the average time spent at a location in a
year increases the weekly wage by about 1%.

Tobit Supply Equation. The spouse labor supply equation
predicts the number of weeks worked as a function of the spouse's
wage, and other variables. It is estimated as a two limit tobit.

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Each variable affects both the probability of working and the amount of time worked conditional upon working at all. Hence, we can consider the effect of the variable on the working population, and its effect on the entire population.

The most important variable, spouse wage, was highly significant and of the predicted sign.[7] The results suggest that a 10% increase in the spouse wage would result in a 12% increase the number of weeks worked, for those spouses who were already working in the market, and about a 5% increase in the supply of weeks worked overall. The number of children in the family, and the presence of preschool children, had a negative effect of weeks worked. Spouses with pre-school age children who were in the market worked about 16.4 fewer weeks than spouses without pre-schoolers.

If the family made a PCS move during the year, a working nonmember spouse lost about 10 weeks of work, other things being equal. For the entire sample, including nonworking spouses, a PCS move reduced weeks worked by about 5. Working spouses stationed in CONUS work about 4.5 weeks more per year than their counterparts working outside of CONUS.

Implications for Spouse Labor Market Rent. Spouse labor supply is found to be relatively responsive to changes in the spouse wage. This makes it important to consider the change in the value of nonmarket time when estimating the losses in spouse labor market opportunities from remaining in the Army. Had labor supply been relatively unresponsive to changes in the spouse wage, the

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[7] The spouse wage variable included in the labor supply equation was the predicted wage from the wage equation. Our "predicted" sign assumes that income effects are small relative to the substitution effect from a wage increase. The data in the DoD survey included weeks of work but not hours of work. Possible implications of this are discussed in the body of the report.

simple difference in earnings would be a good approximation to the loss in labor market rents due to military life.[8]

Our measure of the loss in spouse labor market rents from remaining in the Army begins with estimating (1.1) for each spouse. This will consist largely of a difference in expected wage due to the lower average time spent at a location while in the Army, which we estimate to be approximately 12% under our assumptions. We add to this the value of the expected loss in weeks of work due to more frequent moves associated with military life, and the loss associated with a higher probability of being outside the United States.

The average annual expected loss in labor market rent over the sample is approximately $385. This may seem small, but it is averaged over spouses who have very low probabilities of working at all. Moreover, it is the expected average annual loss while in the Army which is less than the loss, say, in a year in which a PCS move is actually made.[9]

1.3.4 Reenlistment Equation Estimates

Our model of household or family retention behavior is tested by estimating an empirical reenlistment equation. Data on self-assessed reenlistment probabilities, "reenlistment intentions", from the 1985 DoD Survey are used to construct the dependent variable. Our sample includes married Army male enlisted in their first, second, or third term of service. Data on actual reenlistment behavior is clearly preferred. However,

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[8] In equation (1.1), if $H^A=H^B$ the loss is simply the difference in earnings, $(W^A-W^B)H^A$.

[9] In our sample, about 30% move in a year. The lost earnings from a PCS move for a spouse who is a high school graduate and is working is about $2,000. The expected annual loss from a PCS move for this spouse, unconditional on whether she is in the labor market or actually making a move that year, is about $360.

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such data, linked to the survey respondents, was not available at the time of this research.[10]

The reenlistment equation estimated is a "quasi-reduced form". Member pay is estimated simply as current pay and allowances. Civilian pay opportunities are included in reduced form as years of education and occupational dummy variables. The effect of the military retirement system, as well as the effect of censoring in the distribution of tastes for military service, is captured by year and term of service variables.

A structural measure of the expected loss in the spouse's labor market rent from choosing to remain in the Army, computed as described in the previous section, is the most interesting variable in the model. The sign and significance of the estimated coefficient on this variable constitutes the test of the household model. The coefficient is expected to be negative -- the greater the expected loss in spouse labor market rents from remaining in the Army, the lower is the family's probability of reenlisting.

This parsimonious model is estimated as a logit, using ordinary least squares. The sample population is a relatively homogeneous group -- married males in their first, second or third term of service in the Army.

Results. The regression results provide evidence that is generally favorable to the household model of reenlistment behavior. The estimated coefficient on the expected loss in spouse labor market rents is negative and statistically

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[10] Use of reenlistment intentions, rather than actual behavior, may constitute a more stringent test of our model. Our model was developed to predict how a family would behave, not how they say they would behave. To the extent that they differ, using self-assessed reenlistment probabilities rather than actual outcomes means that our model is more likely to be rejected.

significant.[11] The coefficient implies that a $100 decline in
the loss of spouse labor market rent would increase the
probability that the member will reenlist by about 3%. This
suggests an elasticity of the reenlistment probability with
respect to the expected loss in spouse labor market rent of about
-.12 at the means.

The estimated coefficient on member's pay implies that a $100
increase in basic pay and allowances will increase the probability
of reenlistment by about 1%. The elasticity of the probability of
reenlistment with respect to member's pay is about 1.3 at the
means, an estimate well within the range of pay elasticities found
in the literature. An additional year of education for the member
reduces the probability of reenlistment by about 2 percentage
points. If education affects reenlistment behavior only through
its effect on the member's potential civilian earnings, this
implies that an additional year of education increases civilian
earnings by about $300.[12]

A dummy variable is included in the reenlistment equation to
indicate whether the member was married since his last enlistment
or reenlistment decision. The hypothesis is that those members
who married since making a reenlistment decision will have a lower
probability of reenlisting. The reenlistment decision will be the
couple's first. While the member has revealed a taste for
military life by his initial enlistment and, perhaps, subsequent
reenlistments, the newly formed household has not. The estimated
effect is large and significant. The newly wedded couple has a
probability of reenlisting that is approximately 10 percentage
points below that of a couple that has already made an enlistment
or reenlistment decision together. The conventional wisdom is

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[11] The coefficient is -.00073 and the t-ratio is -2.46.

[12] This assumes that the coefficient on the member's civilian
earnings opportunities is equal to the coefficient on Army pay,
but of opposite sign.

that marriage increases the probability of reenlistment. While this is true, the initial effect may be smaller than is currently recognized.

Several alternative specifications of the reenlistment equation were estimated to test the robustness of the results. Generally, the major results are robust to alternative specifications. When the loss in labor market rents is included as an explanatory variable, neither spouse earnings nor number of dependents has a significant effect on the probability of reenlistment. Our measure of spouse earnings loss did appear to be quite collinear with the minority status of the member, a relationship that should be explored in future work.

1.3.5 Policy Implications and Future Research

While the focus of our research was the theoretical and methodological development of a household model of retention behavior, it has produced some empirical results of potential interest for policy.

Policy Implications. Our research concerns the effects of military life on the labor market opportunities of the nonmember spouse and, through the labor opportunities of the spouse, on retention. We have estimated the effect of frequent PCS moves, and moves outside of the United States, on the expected wage of the spouse and on weeks worked. The results have potential implications for rotation and tour length policy, and provide additional insight into the burdens that are potentially placed on the Army family.

Frequent moves appear to affect the financial opportunities of the nonmember spouse in at least three related ways. First, in the year of a Permanent Change of Station move, the working spouse will be able to supply less labor to the market than she otherwise would. If the family is making a move, the marginal value of

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nonmarket time for the spouse increases because of that move. We estimate that a working spouse works approximately 9.5 fewer weeks in the year of a PCS move. The hardship potentially imposed upon the family due to unreimbursed out-of-pocket expenses during a move is compounded by the lost paychecks of the working spouse.[13]

Second, frequent moves reduce the spouse's expected tenure in any given location. This has a direct effect on the wage offers the spouse can expect. Our estimates suggest that a one month increase in the average cumulative time at a location for a calendar year is associated with a 1% higher spouse wage. Taken literally, this means that if the average tour length were increased by 12 months, the average spouse wage would be 6% higher.

Third, it is clear that geographic location affects weeks worked.[14] Our results suggest that working spouses in CONUS will work approximately 4.5 weeks more per year than working spouses outside of the continental United States.

The cost of these factors -- reduced labor supply and lower wage rates -- will vary among Army families. Families in which the nonmember spouse is educated and has few children will typically bear the largest cost. It is these families in which the spouse is most likely to be working and earning high wages.

Explicit, structural estimates of the effect of military life variables on spouse labor market opportunities offer a new

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[13] An Army enlisted family with a working spouse who is a high school graduate forgoes approximately $1,900 because of a PCS move, while a family with a working spouse who is a college graduate looses about $2,800 in income, according to our estimates.

[14] It is also reasonable that location affects the spouse wage. In our data set, we were not able to identify geographic location within the United States, so that an obvious demand side variable is omitted from the analysis.

dimension to a number of policy issues. Consider a decision to increase average tour lengths by 12 months. This would clearly be costly at onerous or particularly undesirable duty stations. However, there would be potentially offsetting benefits in other areas. The frequency of PCS moves would be reduced by roughly 24%, reducing PCS costs directly. The average wage of spouses would rise by about six percent, and the expected loss in the contribution of working spouses to family income because of PCS moves would decline. A simulation of this case using our model suggests that the reenlistment probability of married enlisted members in their first, second, or third term of service would rise by about 3%, on average, from the tour length increase, all else equal. The increase would be larger for families with spouses that have a high probability of working.

Future Research. Overall, we believe our research accomplished its objectives. However, the project has covered a significant amount of territory, much of it quite new, in a relatively short period.   There are a large number of potential research issues that have been left unexplored or only partially explored. A few of these are:

- **Estimation Using Actual Reenlistment Behavior.** We have estimated the model using for enlisted families using self-assessed reenlistment probabilities. The model should be reestimated using actual reenlistment outcomes obtained from data recently made available by DMDC, and using structural estimates of the members ACOL.

- **Estimation for Officer Families.** The loss in labor market rents and the family retention model has been estimated only for enlisted families. A natural extension is to estimate the model for officers.

- **Estimation Pooling Married and Single Members.** A truly general model of reenlistment behavior should be able to explain both the reenlistment behavior of married members and of single members. The household model developed in this research can be extended to include both. The key methodological issue would be the endogeneity of marital status. The model would be estimated using data that pooled observations on married and single soldiers.

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- Spouse Earnings Data. The spouse earnings data from the 1985 DoD Survey that was available at the time of our analysis suffers three shortcomings: (1) it does not include hours of work, which makes it difficult to distinguish variation in the hourly wage from variation in hours of work; (2) it did not allow identification of the specific location of the spouse, which makes it difficult to control for local labor market conditions; and (3) it does not include families who have left active duty, which leaves open the question of whether we have captured all the effects of military life on spouse earnings opportunities. A recently released version of the 1985 DoD Survey allows the researcher to identify families who serve on the same base, and therefore allows the researcher to adjust for local market conditions. Moreover, the 1986 DoD Survey of Reserve Members and Spouses would allow the researcher to estimate wage and labor supply equations for the nonmember spouses of reserve members, who are not affected by the frequent moves of active duty military life. This data, when pooled with data from active duty spouses, can serve as a comparison group from which to infer the effects of military life on the labor market opportunities of active duty spouses. A number of assumptions were necessarily made in making our estimates of the loss in spouse labor market rents. Reestimation with a new data base, the 1986 Reserve Survey, would allow a reexamination of those assumptions.

1.3.6 Outline of the Remainder of the Report

Remainder of this report is organized into seven sections. Section 2 is a review of the literature, including sociological studies on family factors in military retention and econometric retention studies that have included family variables. Section 3 offers an exposition of the economic theory of household decisionmaking as it has been applied to the allocation of time between market and nonmarket activities, and derives a simple model of occupational choice from that framework. The measure of labor market rent or consumer surplus is derived relatively rigorously, and its relationship to an "ACOL" measure is discussed. An analogy between this model of occupational choice and a model of the family migration decision is presented and discussed. Section 4 examines complicating factors when the

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simple model is applied to the Army retention decision and a family ACOL specification is derived. Section 5 develops the system of econometric models that forms the basis of the spouse labor supply model. Section 6 presents the empirical estimates of the labor supply system parameters. In section 7, the estimates of the parameters of the simple household retention model are presented, and their implications and limitations discussed. Section 8 offers a brief summary of the major findings of the report along with its limitations.

2.0 LITERATURE REVIEW

The literature relevant to the development of a household retention decision model comes from two major sources. First, sociological studies of the effects of family factors in the retention decision are reviewed. These studies represent the only attempts to focus on the direct relationship between the military member, the family, and the retention decision.

Second, there are a relatively large number of econometric studies on the retention decision. The focus of these studies has largely been on the individual member, rather than the family, as the decisionmaker. Here, we review the evidence correlating family status and retention behavior, although this relationship is not the major emphasis of these studies. A more general review of the literature on econometric retention models can be found in Black, Hogan, and Sylwester (1987).

2.1 Family Factors in Military Retention: Sociological Literature

Most empirical sociological studies show a connection between spouse or family variables and the retention decision of the service member. These studies attempt to provide policymakers with direct, tangible guidelines to influence the military stay/leave decision. However, the sociological literature is weak on both theoretical and empirical grounds; we will examine these shortfalls later in this section.

Specific studies have focused on one of the military services, using data from a single service.[1] There are few

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[1] For a comprehensive annotation of the sociological literature, see the Review of Military Family Research and Literature Annotated Bibliography (DoD Military Family Resource Center). Hickman and Hunter (1981) also review literature that establishes

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studies analyzing Army specific retention data, so we must rely on the literature from all the Services.

From a survey of Naval personnel, Szoc (1982) finds that spouse opinion concerning a Naval career is one of four variables that directly affects the retention decision of Navy officers and enlisted personnel. Other important variables are satisfaction with Navy family life, job satisfaction, and years of Naval service. Variables with an indirect effect on retention include feelings on family separation from deployments, marital satisfaction, satisfaction with Navy services, and perceived social support.

Farkas and Durning (1982) find that family pressure to leave the Navy is one of the best predictors of reenlistment intention. Using survey data, a measure of family pressure was related to Navy interference with family life, including deployments, time with spouse, time on the job, and social support from supervisors.

Several Air Force studies use data from the Air Force Spouse Survey (AFSS). Lewis (1985) analyzes the AFSS and finds that spouses think that military life is more stressful than civilian life, a result consistent with Kringer (1986) in a similar analysis of the AFSS. Lewis identifies stresses as disruptions caused by work schedules, TDY, exercises, and recalls. Reduced employment opportunities and the resulting loss in family income upon transfer to a new location also exert a negative impact on the family.

Dansby and Hightower (1984) use multivariate analysis of data from the AFSS and the Organizational Assessment Package (OAP) to predict Air Force career intention. The conclusion is that family and spousal attitudes contribute strongly to the model. The

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a link between the retention decision and spousal attitudes or family commitment to the military.

authors offer suggestions to improve family life, including more
spousal job identification, increased leave, compatible family
work schedules, fewer family moves and separations, and improved
services.

Orthner and Pittman (1984) find that family support variables
contribute to Air Force members' job commitments. The authors
test the linkages between family variables in the Air Force job
community and spouse support for Air Force careers using
probability samples and path analysis. Bowen (1985) also uses
path analysis on a sample of 700 Air Force couples to determine a
positive and significant effect of spouse support on.the retention
of both officer and enlisted personnel.

Critique. Most authors of military family literature find a
relationship between family factors and retention. While we
believe that the relationship does exist, there are several
methodological problem˜ ‵.at appear to be common to this
literature, casting s˜me doubt on the validity of the evidence.
Among these problems are a weak or nonexistent theoretical
foundation; the inclusion in the models of clearly endogenous
variables, such as spouse attitudes; failure to distinguish
between correlation and causality; absence of key control
variables, such as differences in compensation; reliance on
intentions rather than actual behavior; and the failure to test
for nonresponse bias in the surveys that serve as the major data
sources.

Any conclusion requires first a hypothesis; there needs to be
some background on the anticipated behavior of service member and
spouse. After determining an expected pattern of family factors
in the military retention decision, the researcher can test the
rationale using various analytic techniques. The majority of
studies in this field begin immediately at the empirical stage.
While the results generally tend to be consistent with intuition,

there is little formal hypothesis testing or attempt to distinguish among competing hypotheses.

In the empirical analysis, one shortcoming is the use of attitudinal measures to predict member's behavior. Spouse and family attitudes are endogenous to a model of overall satisfaction with military life. Spouse satisfaction is correlated with the same factors, unknown to the researcher, that determine the outcome of the retention decision. There will undoubtedly be a strong correlation between spouse attitudes and retention, but this correlation does not imply causation. Moreover, it is no more enlightening of the underlying factors affecting retention behavior than is the correlation between member satisfaction and retention. It is more interesting to know if the spouse's tastes or views had a significant, independent effect on the retention decision after carefully controlling for other factors (e.g., relative pay and living and working conditions) that help form the attitude. The practical implication of this criticism is that policies to improve spouse satisfaction with the Army will have a smaller effect on retention than these studies suggest.

"Path analysis," an approach taken by many of the researchers in this area, forces the analyst to think in terms of a system of structural equations. Hence, this would suggest that the issues of endogeneity and simultaneous equation bias would be addressed in this research. However, in the studies we reviewed, the system of equations in the path analysis tend to be block recursive with independent errors. Problems of simultaneity bias are thereby avoided by assumption.

Finally, low response rates from survey data can introduce nonresponse bias into the models, further reducing confidence in their outcomes. Farkas and Durning (1982) surveyed 2126 Navy officer and enlisted men and women with dependents. The response rate was 40% with a final sample size of 701. Similarly, Szoc's (1982) questionnaire mailed to 5028 Naval personnel had a useable

response rate of only 33.1%.[2] Especially when survey data pertains to family and dependent issues, failure to adjust for differences between respondents and nonrespondents can result in biased parameter estimates. For example, excessive family separation may be a characteristic of nonrespondents who do not have time to complete the survey. Alternatively, families planning to leave the military may respond to the survey at much lower rates than others. Eliminating these families from the data without testing for potential nonresponse bias casts doubts on the accuracy of survey results.

2.2 Family Factors in Military Retention: Economics Literature

In the economics literature, models of the military retention decision are rooted in the theory of occupational choice. The application of the theory of occupational choice to the military begins with early research of the 1970s that estimated the effects of policy variables on the first-term reenlistment decision, continues with the development of the Annualized Cost of Leaving (ACOL) Model that examines the effects of large policy changes in a multidecision framework, and expanded into a post-ACOL era characterized by extensions of the ACOL methodology into dynamic multidimensional time models. We provide first a brief history of occupational choice theory as it relates to military retention, and then review the economic literature with specific reference to family factors.

Some of the earliest work in retention behavior was completed for the Gates Commission (1970). The decision to return to a volunteer force depended in part upon the budget costs of

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[2] See Marjorie Goon and Paul F. Hogan, "An Analysis of Potential Nonresponse Bias in the Air Force MWR CATI Survey", Systems Research and Applications Corporation, July 1987, for a discussion of nonresponse bias in surveys, and an application of a statistical technique to test and adjust for nonresponse bias.

increasing retention and lowering the demand for accessions.
Analysts sought to estimate the increase in reenlistments under
alternative pay policies. Numerous studies estimate the effects
of pay and bonus on the first term retention decision.[3] The
focus of these studies, however, was strictly on the individual.
Family factors were not included simply because the first term
draft-era force consisted almost exclusively of single males.

The development of the ACOL model by Nelson and Warner in
1978 represents a major advancement over earlier work on
individual retention behavior in the military. The ACOL model
provides a basis to determine the horizon over which military and
civilian pay are compared. It selects a nonarbitrary future
leaving point -- the one that maximizes the annualized difference
between the pecuniary returns to staying and the returns to
leaving immediately. It also grounds the estimated retention
equation more directly to individual utility maximizing
decisions.

Post-ACOL generation models extend the range of compensation
and attempt to explain retention patterns over an entire military
career. These models are capable of predicting force structure
implications of broad compensation changes. The Dynamic Retention
Model (DRM) developed by Gotz and McCall (1980)[4] and the
Stochastic Cost of Leaving (SCOL) model developed by Warner (1981)
are examples of models less dependent on specific patterns of past
compensation and force management policy constraints in predicting
the effects of policy changes. The DRM, for example, accounts for

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[3] See, for example, Grubert and Weiher (1970) for estimates
among Navy personnel, Wilburn (1970) for the Air Force, Nelson
(1970) for the Army, and Enns (1975) for an all Service
estimate.

[4] See Gotz, Glenn, and John McCall, Estimating Military
Personnel Retention Rates: Theory and Statistical Method. Rand
Corporation, R-2541-AF, 1980.

the changing distribution of the unobserved individual-specific factors affecting retention.

The ACOL-2 model applied to the reenlistment decision of Navy enlisted personnel by Black, Hogan, and Sylwester (1987) is a recent attempt to overcome the self-selection problem of the ACOL model. A problem with the original ACOL model is that it failed to account for the natural tendency of retention rates to rise with years of service, as those with relatively low "tastes" for service leave. The ACOL-2 model uses the same financial incentive variable as ACOL, but differs in its handling of unobserved heterogeneity or tastes that underlie the self-selection process, and in the explicit inclusion of a transitory random error affecting reenlistment behavior at each point. The ACOL-2 model provides an internally consistent explanation of the observed patterns of retention rates beyond the first term, and corrects for the selectivity bias that may result from failing to account for unobserved heterogeneity in a multidecision model.

Despite advances in modeling military retention behavior, very little empirical and virtually no theoretical work has been done on military retention as a household decision.[5] For the most part, traditional applications in the military focus on individual employment decision behavior -- the spouse, family, or household are not usually significant factors in these models. The contribution of the family to the retention decision usually comes in the simple form of marital or dependent status. We focus the remaining discussion of the econometric literature on those studies that incorporate elements, albeit limited, of the family in the decision process.

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[5] Both the lack of theoretical development and the paucity of empirical results may reflect the scarcity of solid data from which to incorporate household behavior.

In a multinomial logit model to estimate the probabilities of reenlisting or extending versus leaving at the first and second term decision points, Goldberg and Warner (1982) include a variable for the percent married within each of eight different Naval occupational categories. Among first termers, the married variable has a negative effect for all groups in the decision to extend -- signing a contract for less than three years.

In the decision to reenlist -- signing a contract for three to six years -- some occupational groups show a positive relationship between marital status and the dependent variable. The marital status of two groups (non-electronics and logistics) are positive and significant at the one percent level with respect to reenlistment. Another (administrative/media) is significant at about five percent. Of the three occupational groups with negative coefficients for marital status, only one is significant (electronics at the one percent level).

Empirical evidence also shows that self-selection continues with increasing military service at the second-term decision point. The electronics group, for example, is the only group with a consistently negative relationship between marital status and retention at the first term. However, at the second term, this relationship is consistently positive. By the second reenlistment point, this group may begin to realize longer term benefits of married life in the military. These benefits incorporate both the pecuniary returns of family allowances and the nonpecuniary returns of increased family size, including greater savings from the use of commissary and post exchange, child and health care facilities, and schools.

Alternatively, one can consider a model in which the military career decision is made simultaneously with the marriage contract. If this were the case, the "married" variable is more likely to have a negative effect on retention at the decision point following the change in marital status. If most members marry

during their first term of service, one might expect a negative effect at the first term, but a positive or insignificant effect thereafter.[6]

Black, Hogan, and Sylwester (1987) use similar occupational groups of Naval service members to predict enlisted retention. Instead of marital status, this study includes two dummy variables for dependents, one for the presence of two dependents and another for the presence of at least three dependents. Both are associated with higher reenlistment probabilities compared to single persons. After controlling for differences in cash compensation that vary with marital status, such as Basic Allowance for Quarters (BAQ), the authors find that members with dependents are 41% to 58% more likely to reenlist at the first term than otherwise similar single members. They suggest that both job security and in-kind benefits provided by the Navy may be factors influencing the stay/leave decision, but that the result may also be due to the endogeneity of family size in a life cycle model of labor supply.

Other studies also replace the marital status variable with one for dependent status. Lakhani and Gilroy (1984) rationalize that the number of dependents generally contains within itself the effects of marital status. The hypothesis of the authors is that servicemen with dependents are likely to be more risk averse and tend to reenlist rather than face unemployment after separation. Empirical estimates of a trichotomous model of first-term Army retention show that the coefficient for number of dependents is positive and significant. In addition to being more risk

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[6] One might hypothesize a negative effect at the first reenlistment decision following marriage because those members who have changed marital status during the term of service have a new element to consider. Since the member revealed some taste for military life by enlisting in the first place, a marital partner picked at random is unlikely to be more enthusiastic about a military career than the member. Clearly, however, the result depends upon the nature of the marital sorting process.

averse, married servicemen with dependents, more so than married personnel alone, enjoy nonpecuniary benefits of military services and programs. This again implies a relationship between family size, increased returns to staying in the military, and higher retention rates.

Chow and Polich (1980) also address the issue of non-pecuniary in-kind benefits to military families. Better housing made available to personnel with dependents or substantial increments in allowances for quarters, the greater security of service employment relative to civilian employment, increased benefits from free medical care, and savings in purchases made in base exchanges all benefit married individuals or those with dependents more than single members. In fact, data from this study shows that enlisted E3-E5 personnel with one or more dependents (28.1% reenlistment rate) have higher retention rates than personnel with no dependents (17.8%), other things remaining equal.

To capture in-kind payments in their model of the first-term reenlistment decision, the authors include indicator variables for designating whether the individual is receiving the subsistence allowance in kind, whether the individual has no dependents and is receiving the quarters allowance in kind, and whether the individual has dependents and is receiving the quarters allowance in kind. To capture the effects of fringe benefits, the model includes an indicator variable for dependents.

Estimation of the model establishes only one significant relationship -- there is a higher tendency to reenlist among those with dependents and living in military housing quarters. The insignificance of the coefficient for dependent status indicates either that this variable does not adequately measure fringe benefits, or that the fringe benefit package does not strongly affect reenlistment for first termers.

Smith and Goon (1987a) examine the effects of a specific military in-kind benefit on retention -- the Family Support Center (FSC). The study finds slight evidence for a positive effect of Air Force FSCs on officer retention, and slight evidence of higher readiness among both officers and enlisted personnel at bases with FSCs. Multivariate models are estimated in this study merging data from the DoD survey with Air Force personnel files.

While some studies suggest or establish a positive correlation between family factors and retention, other suggest a negative relationship between certain family factors and the retention decision. One facet of military life that has a negative influence on the stay/leave decision is family separation.

Family separation resulting from sea duty may serve to explain differences in the sign of the married coefficient among various occupational groups in Goldberg and Warner (1982). Certain groups of personnel may spend more time at sea because of their occupational specialty. More time at sea translates into more family separation, more of a burden on the family caused by the military, and a higher propensity to leave the service. In the framework we develop later in this paper, family separation may result in an efficient mix of member and nonmember labor in the household production function. In Goldberg and Warner's model, more sea time is generally associated with lower total probabilities of staying. The authors did not, however, interact this variable with marital or dependent status.

Daula and Baldwin (1984) suggest that family separation is an important nonpecuniary variable that may affect the reenlistment decision. In Daula and Baldwin (1985), first term Army members who were married were found to have a higher probability of reenlistment than unmarried members. They attributed this result to the greater level of benefits that accrue to married Army members under existing policies.

Chow and Polich (1980) do include a variable for family separation in their model of the first-term reenlistment decision. However, for those service members with dependents and separated from their families for over 25 percent of the time due to military assignments, there was no significant effect of family separation on the dependent reenlistment decision variable.

Another institutional characteristic of military life that affects the family and retention is frequent relocation. PCS moves discourage investment in job search and human capital by the nonmember spouse, can cause spouse unemployment, and loss of income to the family. Smith and Goon (1987b) find that Air Force officers with wives in the labor force have lower retention rates. Using data from the 1985 DoD survey, empirical estimates show a small, negative relationship between actual retention and spouse labor force participation, with spouse employment effects more negative among young officers.

In summary, the economic literature appears to establish a positive relationship between the probability of remaining in the military and being married, after accounting for the effects of differences in cash compensation. Other than this, very little is known about the relationship of family factors and retention. For example, there has been very little analysis of the factors generating differences in retention behavior among those who are married. Smith and Goon (1987b) is the exception, finding that spouse employment and family separation are negatively related to retention, other things remaining the same.

Critique. Econometric models of the military retention decision are generally sound, but they fail to focus on the family as the decisionmaking unit. Even those studies that include family or household variables (usually marital or dependent status) do not adequately take into account the influence of

spouse and dependents in the decision process. The focus remains on the individual; the family is a peripheral issue.

Part of the problem with the economic literature is lack of suitable data from a single source. Econometric studies either build models around statistical analysis of survey data (e.g., the DoD worldwide surveys) or personnel files (e.g., the Enlisted Master File). Personnel files typically contain good measures of the dependent variable (actual retention behavior), but lack detailed information on the service member's family. Marital and dependent status are often the only family-related measures available. Surveys may contain more detailed family information, but often lack a sufficient measure of retention. Merging these two sources of information may help to overcome this data problem in future analyses.

Considering both the increased importance of women in the labor market and the increased numbers of families in the military, the household has become an important focal point in the retention decision process and in policy formation. A model of occupational choice with the household as the unit of analysis may provide insights upon which to base policy decisions. A useful departure point for the model developed in sections 3.2 and 3.3 is the household production function literature, reviewed in section 3.1. This literature helps us understand the division of labor within the household. It offers a framework for analyzing the effect of military life on the labor market opportunities of the nonmember spouse, and the value the household may place on this potential effect.

The household decision to stay in or leave the Army is similar to the family migration decision in that all the members of the family are directly affected. The decision of the family to move to another state so that one spouse may accept an employment offer affects the employment opportunities of the other spouse, for example. How the potentially disparate effects of the

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migration decision are integrated into the household decision
framework is analogous to an Army family's reenlistment decision.
The migration literature is briefly reviewed in section 3.4 for
the insights into the family reenlistment decision that it may
offer.

3.0 ECONOMIC THEORY OF HOUSEHOLD DECISIONMAKING[1]

Economic theory focuses primarily on the <u>individual</u> as the decisionmaker.[2] Individuals are hypothesized to make choices as if they were maximizing their own utility subject to budget and other constraints. The decision to work -- the labor force participation decision -- and the decision of how many hours to work in the marketplace are derived directly from this individual utility maximization framework.

Occupational choice theory -- the analysis of which job the individual will choose -- has also developed within the framework of individual utility maximization. Individuals are assumed to choose a job, or a time path of jobs, to maximize their lifetime utility. Choices are based upon both the pecuniary (wage and salary) conditions of employment and the nonpecuniary (nonwage) conditions, such as location and risks. It is occupational choice theory, with the individual as the unit of analysis, that has been applied to the military retention problem. Econometric models of military retention, such as the Annualized Cost of Leaving (ACOL) model, are a direct application of the economic theory of occupational choice.

The importance of the <u>household</u>, as opposed to the individual, as the decisionmaking unit has been recognized in the literature concerned with the supply of labor to the market by family members. The household as the unit of analysis has been

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[1] This section and the subsequent two sections benefited from helpful discussions with D. Alton Smith.

[2] An exception to this is mainstream macroeconomic theory, which concentrates on the behavior of major economic aggregates. A common criticism, however, is that macroeconomics has no microeconomic foundation; that is, it is not well grounded in individual decisionmaking. This shortcoming has been redressed over the last twenty years.

particularly prominent in the study of the labor force participation decisions of married women.

3.1   The Household Production Function

In a seminal paper, Mincer (1962) derives the labor supply equation of family members from consumer choice theory, treating the labor supply decision as the symmetrical implication of the demand for leisure. Because the total time available to an individual is fixed, labor supply is the complement of the demand for leisure in a rational allocation of time among competing uses. An advantage of this approach is that the major theoretical results from consumer demand theory are applicable immediately to the labor supply decision.

In his classic paper on the theory of the allocation of time, Becker (1965) develops a model in which leisure time combines with goods purchased in the market place to produce commodities. Market goods and leisure time do not produce utility directly, but are combined in a household production function to yield the commodities, which are arguments in the individual or household utility function. This household production function approach emphasizes that nonmarket hours (and goods purchased in the market) are themselves inputs into a production process. The household purchases foodstuffs, for example, and combines them with their household time to produce dinner.

The notion that leisure time is also an input into home production is a valuable insight emphasized by the household production function approach. Since household members are not likely to be equally productive in household production, members have a comparative advantage in either market labor or home labor, even with identical market wage rates. Hence, there are gains from specialization and division of labor within the household, as within the firm or marketplace.

Another insight of the household production function model is that the true price of a commodity includes the opportunity cost of the time it takes to produce and consume that commodity. There will be substitution among both commodities and methods of producing those commodities as the market value of time (the wage rate) changes.

Finally, the household production function approach permits one to discern movements in labor market behavior (e.g., labor force participation rates) that result from changes in household technology. Such differences can be separated from changes in tastes for leisure in the traditional model. In the conventional approach, leisure time and market goods enter the utility function directly. Changes in labor force participation rates induced by technological innovation affecting the marginal product of time devoted to household production can only be explained by changes in taste. In the household production function approach, the "full price" of the commodity would be reduced through technical innovation. Technology causes an increase in labor force participation by affecting the marginal product of goods relative to time in the household production function.

Pollak and Wachter (1975) note several problems with the household function approach and its application to the allocation of time in labor markets. In particular, unless the household production technology satisfies certain restrictions, the price of a commodity becomes endogenous and a function of the household's preferences.[3] Pollak and Wachter suggest a return to the alternative approach of analyzing the allocation of time and goods

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[3] Two restrictions are constant returns to scale and no joint products. Both of these restrictions serve to make the commodity price independent of the family member's preferences. If, for example, a household member enjoys cooking, the family member produces both a home cooked meal and the pleasure of cooking. Hence, the implicit "price" of the home cooked meal depends upon the individual's preference for cooking.

as a function of market prices and wage rates. Prices, wages, and nonlabor income define the exogenous constraints faced by individuals and households, and offer sufficient information for prediction.[4] We develop this approach below with added insights provided by the household production function literature.

3.2 Conventional Model of Household Labor Supply

The conventional model of household labor typically postulates a household consisting of two adult members. The decision to supply labor hours to the market is part of the more general problem of the allocation of time by household or family members. The approach is to consider the allocation of time as equivalent to the demand for leisure.[5] Leisure time consists of all hours not spent in the labor market. The demand for leisure, then, is similar to the demand for any other good or service. Hence, the theoretical results from consumer choice theory hold. Because the supply of labor hours to the market is simply the complement of the demand for leisure, the results hold also for the labor supply decisions of the family.

Formally, in a one-period model, the household is assumed to act as if it maximizes a utility function consisting of the leisure of both members and market goods, subject to a budget constraint:[6]

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[4] This assumes that all household members participate in the labor market; that is, there is an "interior" solution to the time allocation problem. Complications arise without full participation, because the opportunity cost of leisure is no longer the wage rate at the margin. This problem of "corner" solutions is addressed later.

[5] These hours will consist both of customary "leisure time" and time spent in household production -- caring for children, preparing meals, and maintaining and improving the dwelling.

[6] Those unfamiliar with the notion of a household or family utility function are likely to see a host of problems associated

$$U(L_m, L_f, X) \qquad\qquad (3.1)$$

$$\text{s.t.} \quad W_m T_m + W_f T_f + Y_n = PX + W_m L_m + W_f L_f \qquad (3.2)$$

where

L_m = the leisure of the male adult member of the household

L_f = the leisure of the female adult member of the household

X = goods purchased in the market[7]

W_m, W_f = the market wage rate opportunity of the male and female household member, respectively

T_m, T_f = the total time available to the male and female household members, respectively

P = the price of market goods

Y_n = nonlabor income

Y = $W_m(T_m - L_m) + W_f(T_f - L_f) + Y_n$, total pecuniary income

Y_F = $W_m T_m + W_f T_f + Y_n$, "full" income.

The budget constraint states that total income is equal to total expenditures.[8] Full income, Y_F, includes nonlabor income, Y_n, but also the potential income from allocating all of one's time (T_m, T_f) to the labor market. This income is spent

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with the concept. Most of the these issues entail decisionmaking within the household. Here, we treat the household utility function as a "black box" from which utility maximizing decisions emerge. It is not tautological, however, generating potentially refutable predictions just like the individual's utility function.

[7] We can think of X as either a single, composite good or a vector of goods. In the conventional model, the distinction is not relevant to the analysis, though in the models of household production discussed below, the individual goods are part of the analysis.

[8] The left-hand side of equation (2) is referred to as "full income." It includes the market value of the household's time.

explicitly, by purchasing goods X, and implicitly, by buying leisure at its opportunity cost, W_m, and W_f.

Maximizing equation (3.1) subject to (3.2) with respect to its arguments yields a set of first-order conditions. From these, we can derive the supply curve for hours of work for both adult members of the household as a function of the market wage rates of each member, nonlabor income, and the price of markets goods:[9]

$$S_m = S_m(W_m, W_f, Y_n, P) \tag{3.3}$$

$$S_f = S_f(W_f, W_m, Y_n, P) \tag{3.4}$$

This simple model assumes an interior solution -- it assumes that both adult members supply a positive quantity of labor hours to the market.[10] A salient characteristic of this model is that the opportunity costs of leisure, or more generally, nonmarket time, is the market wage. The results from consumer choice theory suggest the following income-compensated own-wage effects on the supply of hours to the market:

$$dS_f/dW_f|_{U_o} > 0 \ ; \ dS_m/dW_m|_{U_o} > 0 \tag{3.5}$$

The full effect of a change in wages is ambiguous. A negative income effect may dominate the positive substitution

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[9] Note that $T = S + L$; that is, total hours allocated to leisure plus total hours allocated to work will equal the hours available, by definition.

[10] When one spouse is out of the labor market, the response of the other spouse to a change in the own wage is expected to be smaller than when both spouses participate. Intuitively, the reason for this is that the non-participating spouse is at a "corner solution" of zero hours worked. Hence, the non-participating spouse cannot reduce hours worked and devote more time to home production in response to an increase in hours worked of the spouse enjoying a wage increase. See Michael Ransom, "The Labor Supply of Married Men: A Switching Regressions Model", Journal of Labor Economics, v.5, no.1 January, 1987, for an elaboration of this point.

effect on the supply of hours to the market.[11] The income-compensated cross partials are symmetric:

$$dS_m/dW_f \big|_{U_O} = dS_f/dW_m \big|_{U_O}$$

Perhaps the most interesting application of this simple model is the effect of an increase in the market wage of one spouse on the hours supplied to the labor market of the other spouse; that is, dS_m/dW_f (or dS_f/dW_m). We will assume that the sign is negative -- an increase in the market wage of one spouse reduces the time allocated to the labor market for the other spouse, holding all other factors constant.[12]

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[11] This is an implication of the Slutsky decomposition equation:

$$dS_m/dW_m = dS_m/dW_m \big|_{U_O} + S_m dS_m/dY_F$$

The total uncompensated effect of a change in the household member's wage on hours of work is the sum of the pure substitution effect (where utility is constant) and the income effect on hours of market labor induced by the wage change. The pure substitution effect is necessarily positive. The income effect on hours of work will be negative if leisure is a normal good. Hence, the total effect on hours devoted to the labor market of an increase in the wage is ambiguous. If the income effect outweighs the substitution effect, the supply curve of labor is said to be "backward bending."

[12] This result is not dictated by the mathematics of the problem. If household members' leisure time were strongly complementary -- that is, if member A received no utility from an hour of leisure time unless it were spent with member B and vice versa -- the effect could conceivably be different. But this is unlikely. Consider two cases. First, if the increase in the spouse's wage increases own supply of labor to the market, the remaining family member is likely to increase leisure (or household production) time because we have assumed leisure is a normal good and because the marginal product of home production has increased. This assumes that the spouses are substitutes. Alternatively, if a strong income effect results in a reduction in hours allocated to the market of the spouse who received the wage increase, the other spouse would also increase leisure time due to the same income effect. Only in the unlikely case where members' leisure time were strong complements would an increase in one member's market wage result in a decrease in the other's leisure.

3.3 Implications of the Simple Model for Occupational Choice

To our knowledge, this simple model has not been applied directly to the problem of occupational choice, but to do so in the one-period case appears to be relatively straightforward. In this section we construct a simple theoretical model of occupational choice of the household based upon a one period model of household labor supply and apply it directly to the military retention decision.

We derive an expression that is approximately equivalent to the Marshallian consumer surplus, or labor market rent, from reenlisting or remaining in the Army rather than entering the civilian sector. A key point is that the value of home production or leisure time must be considered when estimating the effect of military life on potential spouse earnings and in calculating the net incentive to stay.

3.3.1 Change in Rents as an Incentive to Reenlist

In this section, we derive an expression that is intended to approximate a measure of the household's "willingness to pay" to stay in the Army rather than enter the civilian sector. It is an approximation of the compensating variation of consumer surplus when considering the demand for leisure or non-market time, or producer surplus, when considering its mirror image, the supply of time to the labor market.

In sections 5 and 6 of this paper, the concepts we present in this section are related directly to the spouse's labor market supply equation, and the change in labor market "rent" is calculated.[13]

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[13] Most of section 3.3.1 is devoted to providing a relatively rigorous, but somewhat tedious, derivation of an approximation to

Recall the household utility function: $U(L_m, L_f, X)$. The family is assumed to maximize this function, subject to a constraint on total income:

$$\max U(L_m, L_f, X) \tag{3.6}$$

$$\text{subject to } PX = (T_m - L_m)W_m + (T_f - L_f)W_f + Y_n \tag{3.7}$$
$$= Y$$
$$T_m \geq L_m, \quad T_f \geq L_f$$

Setting the price level, P, to unity and substituting the income constraint directly into the family utility function, we have:

$$U = U(L_m, L_f, (T_m - L_m)W_m + (T_f - L_f)W_f + Y_n) \tag{3.8}$$

Consider two states for the household. In state A, one member is in the Army, and the other member makes an optimal labor-leisure choice conditional upon the member remaining in the Army. In state B, both members make a jointly optimal occupational choice decision and labor-leisure choice, subject only to the constraint that they are not in the military. The household utility of each state is given by:

$$\text{State A:} \quad U^A = U(L_m, L_f, (T_m - L_m)W^A_m + (T_f - L_f)W^A_f + Y_n) \tag{3.9}$$

$$\text{State B:} \quad U^B = U(L_m, L_f, (T_m - L_m)W^B_m + (T_f - L_f)W^B_f + Y_n) \tag{3.10}$$

In the occupational choice decision, the family is assumed to compare the "utility" from reenlisting in the Army from the utility anticipated from leaving and entering the civilian sector. An important part of this difference is the earnings

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the change in labor market rent or consumer surplus associated with reenlisting in the Army rather than entering the civilian sector. The casual reader may want to glance through this section rather quickly. We return to the concept in a more concrete way in sections 5 and 6, where the change in labor market rent is calculated from the spouse's labor supply equation.

opportunities. In the traditional model based upon individual decisionmaking, one would consider only the wage opportunities of the member. For example, a model like ACOL considers only the stream of potential military and civilian earnings of the member. In this simple model of household behavior, the wage opportunities of both spouses must be considered.

A characterization of this decision, focusing on the earnings opportunities, is, stay if:

$$U^A > U^B \qquad (3.11)$$

Or, stay if:

$$U(L_m, L_f, (T_m - L_m)W^A_m + (T_f - L_f)W^A_f + Y_n) >$$

$$U(L_m, L_f, (T_m - L_m)W^B_m + (T_f - L_f)W^B_f + Y_n) \qquad (3.12)$$

Market wages of each spouse may differ in the two states and the quantity of time devoted to the labor market (and time devoted to household production) adjusts in response to the wage rates to maximize $U(...)$. We can approximate an explicit numerical evaluation of $U(....)$ at (W^A_m, W^A_f) and (W^B_m, W^B_f) by totally differentiating the indirect utility function and setting all differentials except DW_m and DW_f equal to zero.[14]

The indirect utility function corresponding to the direct utility function in equation (3.8) may be written as:[15]

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[14] We will denote partial differentials by "d..." and total differentials by "D...".

[15] To derive the indirect utility function, form the Langrangian expression associated with equation (3.8). From the first order conditions, solve for the demand curves for leisure for each spouse and the family's demand for market goods:

$$L_m = L_m(W_m, W_f, Y)$$

$$L_f = L_f(W_m, W_f, Y)$$

$$U=U(L_m(W_m,W_f,Y),L_f(W_m,W_f,Y),X(Y))^{16} \qquad (3.13)$$

Differentiating (3.13) totally with respect to W_m and W_f and collecting terms we obtain the change in utility associated with a change in the member's and spouse's wage:[17]

$$X=X(W_m,W_f,Y)$$

Note that the supply curve of hours worked for each family member is directly related to the demand curve for leisure:

$$S_m=T_m-L_m(W_m,W_f,Y)$$

$$S_f=T_f-L_f(W_m,W_f,Y)$$

Substituting the demand curves back into the utility function, we obtain the equation shown in the text. Note that the advantage of this approach is that the family is "on" its demand curve for leisure or non-market time and therefore is at the utility maximizing level of L_M, L_f, and X for any given wage and income.

[16] Strictly speaking, the indirect utility function should be written (with X as the numeraire) as

$$U=U(L_m(W_m,W_f,Y),L_f(W_m,W_f,Y),X(W_m,W_f,Y))$$

We ignore any direct substitution effects of changes in wage rates on the demand for X. These effects are interesting if the analysis were to focus on "commodities" produced by combining time and market goods in a household production function. Since we are not interested in distinguishing time-intensive from market goods intensive commodities, ignoring these substitution effects is of little consequence.

[17] We denote partial derivatives by "d" and total derivatives by "D". "U_n" denotes the partial derivative of the utility function, $U(...)$ with respect to the argument that is denoted by "n". For example, U_{LM} is the change in utility associated with a change in the leisure, or non-market time, of the member.

$$DU=\{[UL_m(dL_m/dW_m) + UL_m(dL_m/dY)((T_m-L_m) - W_m(dL_m/dW_m)) +$$
$$UL_f(dL_f/dW_m) + UL_f(dL_f/dY)((T_m-L_m) - W_f(dL_m/dW_m))] +$$
$$[U_X(dX/dY)((T_m-L_m) - W_m(dL_m/dW_m)) - U_X(dX/dY)W_f(dL_f/dW_m)]\}DW_m$$

$$+ \{[UL_m(dL_m/dW_f) + U_{Lm}(dL_m/dY)((T_f-L_f) - W_f(dL_f/dW_f))$$
$$+ UL_f(dL_f/dW_f) + UL_f(dL_f/dY)((T_f-L_f) - W_f(dL_f/dW_f))$$
$$+ [U_X(dX/dY)((T_f-L_f) - W_f(dL_f/dW_f)) - U_X(dX/dY)W_m(dL_m/dW_f)]\}DW_f$$
$$(3.14)$$

Collecting terms and setting DW_m and DW_f equal to $(W^A{}_m-W^B{}_m)$ and $(W^A{}_f-W^B{}_f)$, respectively, we obtain:

$$U^A-U^B=-\{[U_{Lm}(dL_m/dW_m) + U_{Lm}(d_{Lm}/dY)((T_m-L_m) - W_m(dLm/dWm)) +$$
$$U_{Lf}(dL_f/dW_m) + U_{Lf}(dL_f/dY)((T_m-L_m) - W_f(dL_m/dW_m))] +$$
$$[U_X(dX/dY(T_m-L_m - W_m(dL_m/dW_m)) -$$
$$U_X(dX/dY)W_f(dL_f/dW_m)]\}(W^A{}_m-W^B{}_m)$$
$$+$$
$$\{[U_{Lm}(dL_m/dW_f) + U_{Lm}(dL_m/dY)((T_f-L_f) - W_f(dL_f/dW_f)) +$$
$$U_{Lf}(dL_f/dW_f) + U_{Lf}(dL_f/dY)((T_f-L_f) - W_f(dLf/dW_f)) +$$
$$[U_X(dX/dY)((T_f-L_f) - W_f(dL_f/dW_f)) -$$
$$U_X(dX/dY)W_m(dL_m/dW_f)]\}(W^A{}_f-W^B{}_f) \qquad (3.15)$$

The first bracketed portion of equation (3.15) is the approximate difference in utility associated with a difference in the wage rate in state A and B for the member spouse, W_m. It consists of two parts. The first is (1) the change in utility associated with a change in leisure or home production time of the member, induced by the substitution effect of a change in the wage and an income effect on the demand for leisure induced by that change, plus (2) the change in utility associated with the change in leisure or home production time of the nonmember spouse induced by the difference in the member's wage in the two states. The second part is the difference in utility that is due to the change in income induced by the difference in the W_m in the two states.

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The second bracketed expression is a similar difference in
utility between the two states that is induced by a difference in
the nonmember spouse's wage in the two states, W_f. Note that

$$U_X dX/dY = (dU/dX)(dX/dY) = U_Y \qquad (3.16)$$

Divide equation (3.15) through by U_Y, the marginal utility of
income, and obtain:

$$
\begin{aligned}
(U^A - U^B)/U_Y = &\sim ([(U_{Lm}/U_Y)(dL_m/dW_m) + (U_{Lm}/U_Y)(d_{Lm}/dY)((T_m - L_m) - \\
&W_m(dLm/dWm)) + (U_{Lf}/U_Y)(dL_f/dW_m) + \\
&(U_{Lf}/U_Y)(dL_f/dY)((T_m - L_m) - W_f(dL_f/dW_m))] + [((T_m - L_m \\
&- W_m(dL_m/dW_m)) - W_f(dL_f/dW_m))](W^A_m - W^B_m) \\
\\
&+ ([(U_{Lm}/U_Y)(dL_m/dW_f) + (\dot{U}_{Lm}/U_Y)(dL_m/dY)((T_f - L_f) - \\
&W_f(dL_f/dW_f)) + (U_{Lf}/U_Y)(dL_f/dW_f) + \\
&(U_{Lf}/U_Y)(dL_f/dY)((T_f - L_f) - W_f(dLf/dW_f))] + [((T_f - \\
&L_f) - W_f(dL_f/dW_f)) - W_m(dL_m/dW_f))](W^A f - W^B f)
\end{aligned}
$$

$$(3.17)$$

The expression, $(U^A - U^B)/U_Y$, is an approximation of the dollar-
equivalent value of the change in utility from moving from state A
to state B that results from the differences in member and spouse
wage rates in the two states. It is an approximation of the
consumer surplus or the amount the family would be willing to pay
in order to reenlist rather leave the military.[18]

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[18] The concept of consumer surplus or labor market rents is
invoked in order to avoid valuing leisure, or home production
time, at zero. This is particularly important for estimating the
value of labor market earnings due to military life for spouses
who are not observed to be working. This concept will be
developed as we proceed.

Our approximation is based upon the Marshallian consumer
surplus. In this application, it is an approximate measure of the
change in labor market rents.

The concept of the "compensating variation" of consumer
surplus, of which our measure is an approximation, is the

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Now, consider the actual decision to reenlist in the Army or remain in military service. For the member, we assume that the hours of work in each state are approximately the same -- the hours typically associated with a full time job.[19] That is, assume that:

$$dLm/dW_m = dL_m/dW_f = dL_m/dY = 0 \qquad (3.18)$$

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following:

Let $V = V(W^A_m, W^A_f, Y_n)$ be the utility achieved by the family at the wage rates offered when remaining in the Army, state A, where V is the indirect utility function. The utility level obtained from entering the civilian sector, state B, is $VB = V(W^B_m, W^B_f, Y_n)$. The compensating variation of consumer surplus is that dollar amount, Y^*, which solves:

$$V(W^A_m, W^A_f, Y_n) = V(W^B_m, W^B_f, Y_n - Y^*))$$

In our context, this becomes a measure of the net labor market rent from state A relative B. Note that the compensating variation of consumer surplus, Y^*, that solves the above equation may be positive or negative, depending upon which state offers the higher utility.

A more intuitive exposition of this concept is provided in sections 5 and 6. There, we show how the change in consumer surplus, or labor market "rent" may be estimated directly from the spouse's labor supply curve.

The literature on the use of consumer surplus as a welfare measure is long, distinguished and controversial. The most obvious problem with this measure is that it assumes that U_y, the marginal utility of income, is constant over the area of the change. In general, this is not the case. The most prominent model of the active duty retention decision, the Annualized Cost of Leaving (ACOL) model, implicitly makes this assumption. The relationship between our measure of the "cost of leaving" (i.e., the amount the member would be willing to pay to reenlist, other things being equal) and the ACOL model is discussed in the text.

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[19] This has been the implicit assumption of virtually all occupational choice models of the military reenlistment decision. Unfortunately, the notion that the member must accept a wage and hours of work "package" as an all or none decision, rather than choosing hours of work given the wage offer vitiates the use of an indirect utility function for the member.

Further, making the above assumption implies that any change in spouse leisure or home production time, L_f, in response to a change in the member's wage is a pure income effect. Simplifying equation (15) under these assumptions, we obtain:

$$(U^A-U^B)/U_Y=-\{[(T_m-L_m)]+$$
$$[((U_{Lf}/U_Y)(dL_f/dY)((T_m-L_m)-W_f(dL_f/dW_m)))]\}(W^A_m-W^B_m)$$

$$+$$

$$\{[((T_f-L_f)-W_f(dL_f/dW_f))]+[((U_{Lf}/U_Y)(dL_f/dW_f)+$$
$$(U_{Lf}/U_Y)(dL_f/dY)((T_f-L_f)-W_f(dL_f/dW_f)))(W^Af-W^Bf)$$
$$=DR \qquad (3.19)$$

3.3.2 Interpretation as "Rent" or Producer Surplus

The difference in "rent" between the two states is denoted "DR". Consider, once more, the interpretation of this simplified expression for the difference.

The difference in rent due to the difference in the member's wage between the two states, $W^A_m-W^B_m$, is the sum of two components in (3.19). The first is just the difference in the member's earnings. This is the equivalent of a one-period Annualized Cost of Leaving or ACOL that is prominent in the models of individual occupational choice that have been applied to the retention decision.

The second component is the net value of the spouse's adjustment to the difference in the member's wage rate. By our assumption, it is a pure income effect, and is the sum of the value of the change in the spouse's leisure or home production time and the value of the change in spouse earnings. This effect

is ignored in models of occupational choice focused on the individual. It is likely to be of second order importance.[20]

The difference in rent due to the difference in the spouse's wage rate between each state, $W^A_f - W^B_f$, is again the sum of two components. The first is the value of the change in income due to the difference in wage rates. This includes both the "ACOL" measure that assumes no change in time devoted to the labor market and the net supply response to changes in the wage rate. The second component is the change in the value of leisure, or home production time, associated with the change in the amount of time devoted to the labor market.

The equations can be reinterpreted in terms of the supply curve of market labor for both the member and the spouse. We have seen that the supply curve of labor is simply the mirror image of the demand curve of leisure, or home production time. The area under the supply curve of labor up to the quantity of labor supplied reflects the value, to the household, of home production foregone, or the "opportunity cost" of working. The net value of working, then, is simply the area above the supply curve but below the wage line. This is the quantity we have called "labor market rent".

In equation (3.19) this quantity is approximated for small changes in the wage rate. Most interesting are the calculations involving the spouse, because we have assumed that the supply of labor is constant for the member. The second bracketed expression in (3.19) simply calculates the dollar equivalent value of the change in income resulting from a change in the spouse's wage plus

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[20] It is a pure income effect because we have assumed that the member does not change his allocation of time between home production or leisure and the marketplace. Note that the net effect of the spouse's adjustment will be positive, because the spouse has the option not to change the allocation of time between market work and home production or leisure in response to a change in the member's wage, in which case this term would drop out.

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the dollar equivalent value of a change in home production, or
leisure, resulting from a change in the allocation of time between
home and the marketplace. That is, it approximates the area
between the two wage rates, as the wage lines intersect the spouse
supply curve. See figure 3.1. The important point for our
analysis is that the change in income resulting from a difference
in wage rates overstates the effect on family welfare when the
quantity of labor supplied to the market changes, because it
ignores the value of home production or leisure time. In
subsequent sections, we calculate the expected difference in labor
market rents for the spouse should the Army family choose to
leave, rather than the difference in earnings, to account for
differences in the quantity of labor supplied to the market.
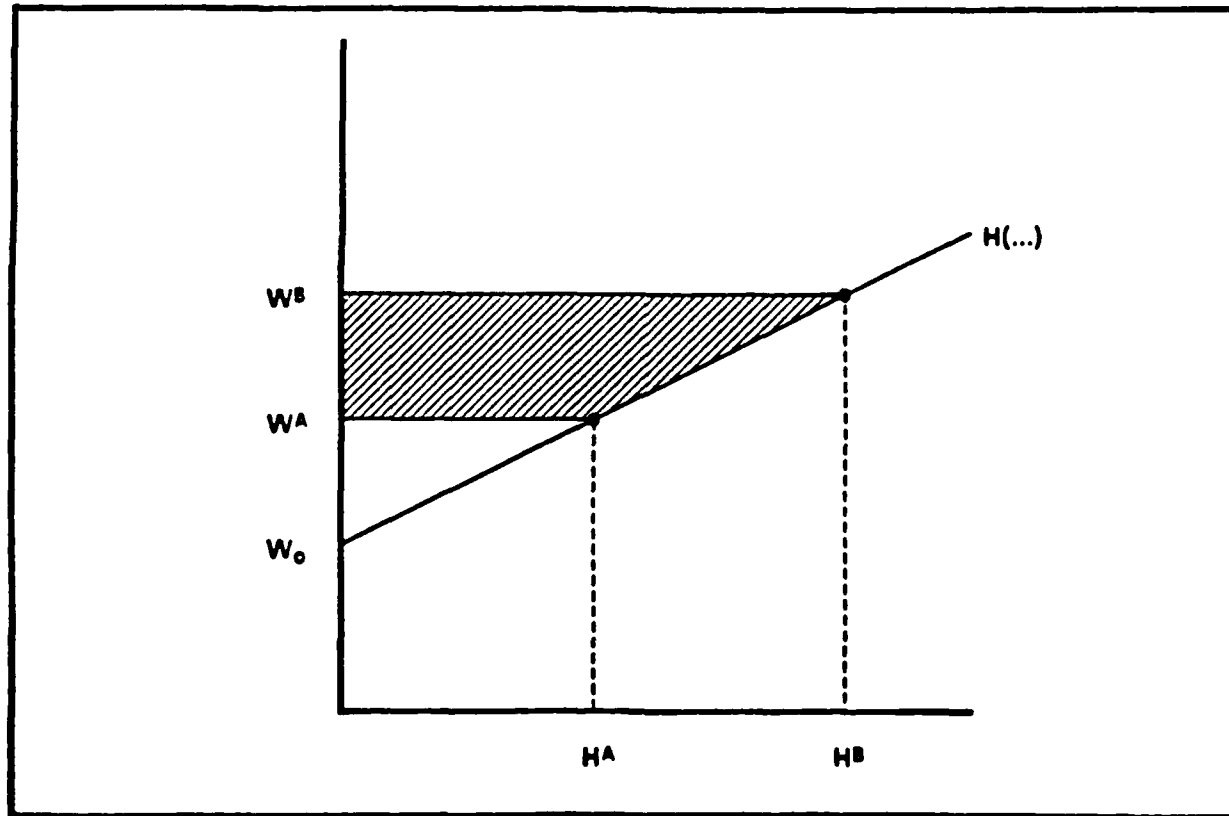
280-0002

FIGURE 3.1:   LOSS IN SPOUSE LABOR MARKET RENTS

Typically, a career in the Army entails frequent moves.
Frequent moves will reduce the expected job tenure of the

nonmember spouse for a given job prospect. This, in turn, reduces
the returns to job search by the nonmember spouse, reduces the
incentive to invest in general human capital by the spouse, and
reduces the incentive of firms to invest in specific human capital
for the spouses of members. More generally, the Army constrains
the location of the household, reducing the opportunity set for
the household to achieve a joint maximum of (3.6). Hence, we
would expect that $W_f^A < W_f^B$.

This analysis may help to clarify an important insight. The
value of the increased income that a nonmember spouse may generate
by increasing the time devoted to the labor market in response to
a higher wage overstates the change in family utility. The value
of this change in income is offset, to an extent, by the value of
the reduction in time devoted to household production. Clearly,
the net effect will be to increase family utility,[21] but the
change in gross earnings overstates this increase.

3.3.3 A One-Period Retention Model

The rational criterion for choosing to reenlist or remain in
the Army for the ith family is, reenlist if:

$$DR_i > 0. \hspace{3cm} (3.20)$$

where DR_i is an approximation of the net labor market rent from
remaining in the Army rather than entering the civilian sector.

There will also be a set of observable factors correlated
with the interaction of tastes and non-pecuniary differences
between reenlisting or remaining in the Army and leaving to enter
the civilian sector. Let these factors be denoted by XB, where X

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[21] This is apparent because the nonmember spouse could always
choose to keep the time devoted to the labor market constant in
response to the higher wage.

is a vector of individual and family characteristics correlated with tastes and factors related to non-pecuniary differences, and B is a vector of coefficients.

In addition, however, there will be factors unobserved by the researcher that affect the family's decision, such as the interaction of tastes and differences in nonpecuniary factors between state A and state B, as well as unobserved random shocks, to the measure, DR.

Denote these unobserved factors coupled with an unobserved random shock as "e". Further, assume that e is distributed independently and identically across all Army households with mean zero and finite variance. The family will reenlist or remain in the Army if:

$$DR_i + X_iB + e_i > 0 \qquad (3.21)$$

The retention probability is:

$$= \int_{-(DR+XB)}^{\infty} f(e)\, d\,e \qquad (3.22)$$

where f(e) is the probability density function of e. If f(e) is the normal density, for example, equation (3.22) can be estimated as a probit.

We will examine how we can measure DR_i empirically in sections 5 and 6.

3.4 An Analogy With the Economics of the Family Migration Decision

To our knowledge, a household, or family, decision model has not been applied directly to the occupational choice decision. Interestingly, however, the family migration decision has been formulated in a manner that is strikingly similar to the household reenlistment decision in the Army.

Mincer (1978) formulates the family migration decision as whether to move to a different labor market area, or to remain in the current market.[22] The benefits and costs of moving consist of changes in the return to time spent in the labor market for each of the members of the household, moving expenses, and of nonpecuniary costs, such as leaving friends and acquaintances, or the costs of changing schools if children are present.

Assume that there are two adult members of the household, m and f. Let the present value of the benefits and costs of moving to a new labor market area be B and C, respectively. Then, Mincer's simple criterion for moving is that the family's net gain from migrating, G, is positive. Or,

$$G = G_m + G_f = (B_m - C_m) + (B_f - C_f) > 0$$

Note that the "family" may choose to migrate even though the effects on one of the members may be negative. For example, G_f could be negative even though G is positive. In the case, the spouse who, individually, appears to be made worse off from the migration decision is called a "tied mover". Similarly, in a family for whom G is negative, a spouse who would have been,

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[22] See Jacob Mincer, "Family Migration Decisions", _Journal of Political Economy_, v. 86, no.9 October, 1978, pp.749-775.

individually, better off by moving is termed a "tied stayer" in this literature.[23]

The analogy with the household model of the reenlistment decision is straightforward. If the Army family chooses to reenlist, despite, perhaps, negative effects on the nonmember spouse's labor market opportunities, the nonmember spouse might be considered a "tied stayer". If the member leaves even though it would appear that his (individual) earnings opportunities are better in the Army, he is analogous to the "tied mover". Finally, the analogy with the family migration model suggests an important reason for a household model of the reenlistment decision. By adopting the perspective of the family, the model should permit explanations of reenlistment behavior that are simply beyond the scope of models that focus solely on the individual member.

The literature on migration has spawned a closely related literature concerned with the magnitude and duration of labor market effects on the "tied mover". The tied mover is typically the wife, and is analogous to the nonmember spouse in the Army reenlistment decision. Sandell (1977)[24] finds that, for those families that migrate, the earnings of the husband increase, while those of the wife suffer a (temporary) decline largely due to a loss in the number of weeks worked. He notes that the decision to migrate is rational, in that the family is made better off as a whole. Moreover, there is no evidence that the potential earnings

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[23] When the individual components of G are large and of opposite signs, we have the rudiments of a theory of family instability. That is, when individual members of the family have large incentives to go in opposite directions, one can predict an increased probability of divorce. This has an analogy with our household model of the reenlistment decision, but the implications are beyond the scope of the current effort.

[24] Steven H. Sandell, "Women and the Economics of Family Migration", Review of Economics and Statistics, v. 59, November 1977, pp. 405-414.

of the husband are treated differently than the potential earnings of the wife in the decision to migrate.[25]

Spitze (1984) finds that the effect of migration on the tied spouse's (typically, the wife) earnings lasts no longer than a year or two.[26] The larger effects, it is suggested, may be upon occupational choice. Those spouses who might expect to be tied movers may choose not to enter occupations where this is costly, such as the professional practice of law or medicine. Similarly, those spouses who are in occupations in which frequent moving is likely to be quite costly may choose not to marry, or separate from, spouses who are likely to place such demands upon them. Hence, self-selection, or sorting behavior, is likely to affect any data on the earnings of families who chose to migrate.

The literature on the effect of migration on the earnings of the tied spouse offers insights into similar effects that may occur to the labor market earnings of nonmember spouses due to frequent Permanent Change of Station (PCS) moves. Again, the analogy is clear. However, one may expect that the effects on potential earnings may be greater for the military family. First, the military family can expect to move roughly every three years, as a matter of policy. Second, the military is more easily identified as a frequently moving profession than most civilian occupations. Hence, the nonmember spouse may face reduced labor market opportunities because of the expectation of turnover. Third, the civilian family will tend to move to locations where

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[25] That is, the decision to migrate based upon the net effect on family income is rational, and independent of the source of that income. The implication of this result for the family reenlistment decision is that the net effect on family earnings is the important variable. However, one must be careful in generalizing the results, because they are based largely on those who migrated, and are unadjusted for potential self-selection problems.

[26] Glenna Spitze, "The Effect of Family Migration on Wives' Employment: How Long Does It Last?", Social Science Quarterly, v.65, March 1984, pp.21-36.

labor market conditions for the family are better, on average, than where they came from, increasing the probability that the local labor market opportunities will be reasonably good for the tied spouse. The Army assigns duty stations to its members quite independently of local civilian labor market conditions. On the other hand, Spitze and others have suggested that there may be a significant amount of self-selection and sorting that is especially relevant to family formation of Army members, so that any direct comparisons between military and civilian families must be undertaken cautiously.

4.0 INSTITUTIONAL FACTORS AFFECTING THE SIMPLE MODEL

The simple household reenlistment model developed largely in section 3.3 serves as a basic foundation for analyzing the retention decision from an occupational choice perspective. It offers a reinterpretation of "ACOL" in terms of labor market rent, and provides insight into how to capture the value of non-market time. However, it must necessarily be modified to capture some of the salient institutional details of the Army. Some of these details were alluded to in the previous section. In this section they are explored in somewhat more detail.

4.1 Hours of Work

An assumption underlying the indirect utility function approach is that, given the wage rate, the individual is free to adjust his hours of work to achieve an optimum allocation of time between labor and leisure (or other nonmarket, household activities). This allocation is shown in Figure 4-1 below. The wage rate is represented by the budget line (W_m), indicating the rate at which the labor market allows him to trade hours of leisure for income. His indifference curves (I_0, I_1, I_2) represent the rate at which he is willing to trade leisure hours for income, holding utility constant. Starting at the maximum amount of leisure available to him, given by the intersection of the budget line with the horizontal axis, he will continue to supply labor hours until he reaches point A, tangent to his indifference curves. At this point, the rate at which he is willing to trade leisure hours for income is just equal to the rate at which he can trade. Beyond this point, he values additional hours of leisure more than he values the income additional labor hours would generate.
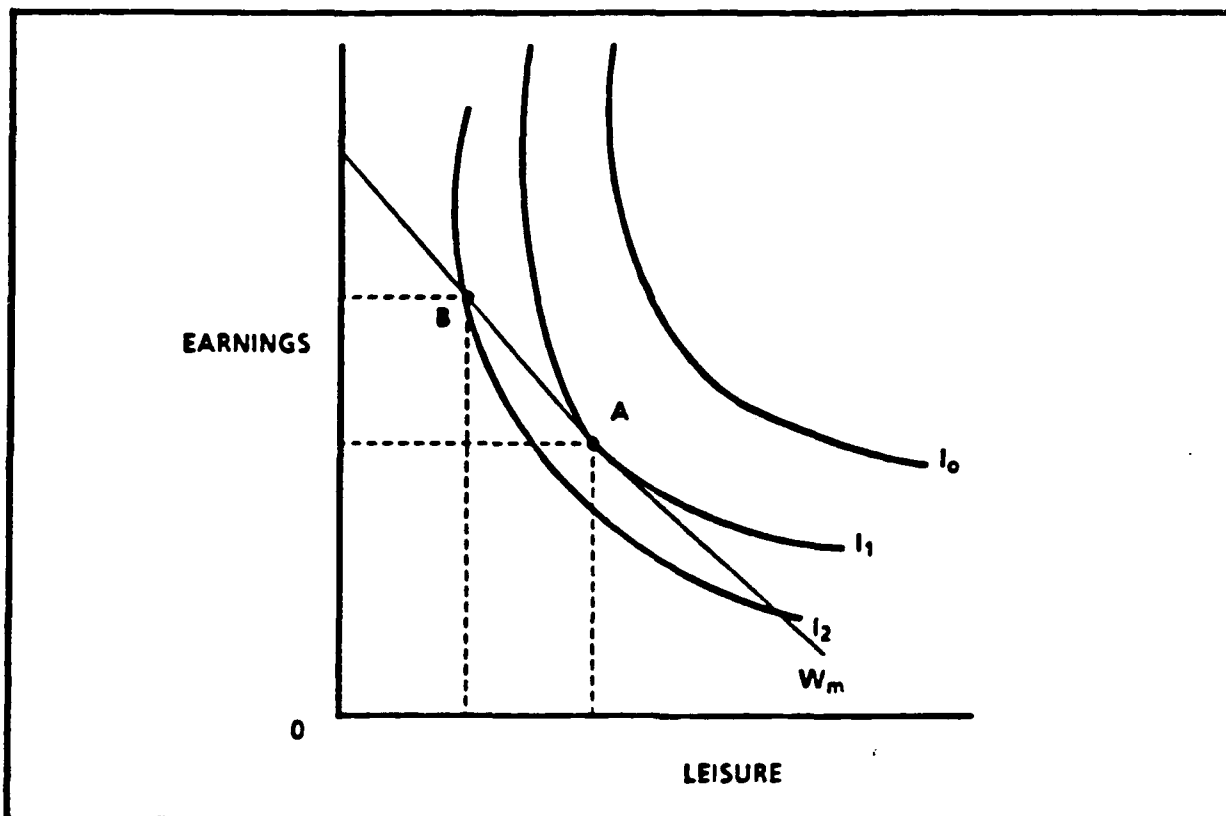
280-0001

Figure 4-1. Optimum Allocation of Time Between Labor and Leisure. The individual optimizes time allocation at point A, where his indifference curve is tangent to his wage rate or budget line. At point A, the marginal value of leisure is equal to the wage rate. Remaining in the Army may force the member to accept point B, where he prefers more leisure and less hours of work. At point B, the value of leisure exceeds the wage rate at the margin.

At the optimal allocation of time, the value of leisure at the margin is equal to the wage rate. Because it is assumed that the individual can adjust hours of work freely at the stated wage, the wage rate offers sufficient information with which to evaluate an occupation. Those who value leisure less than others on average will work more hours at a given wage, and those who value leisure more, on average, will work less. At the margin, leisure lovers and workaholics will value leisure at the same rate, if they face the same wage.

In the Army (and in other occupations as well) the employment offer is similar to an all-or-none choice. The offer consists of an annual rate of pay and working hours that vary among skills and over time, but which are largely at the Army's rather than the soldier's discretion. Hence, only by chance would the combination of pay and hours offered by the Army equal that which the individual or household would choose at the implicit wage rate. In the figure, the member must accept point B, a particular combination of pay and hours, if he chooses to remain in the Army. Note that at B, he would prefer to consume additional leisure by reducing his hours of work but he is unable to do so.

This observation does not mean that the individual would necessarily choose not to reenlist. Rather, it suggests that the employment offer cannot be summarized and compared to other offers based solely on the wage rate.

If an individual is not free to choose his hours of work in response to a wage offer, there are several implications for a model of occupational choice. First, one must compare both the wage and required hours of work of alternative occupations. This is implicit in most models of military retention, including ACOL, which holds hours of work constant in its comparisons.

Second, because the marginal value of leisure time may not equal the implicit Army wage rate, the value of an additional hour of leisure will vary depending upon the household's circumstances. For example, those married members with children may value an additional hour of leisure more than members without children, because their productivity in the household is greater, at the constrained margin. Thus, a model which ignores differences in the value of leisure time (or household production) will have less predictive power than one which includes variables that attempt to

capture factors that are likely to affect the marginal value of
leisure time.[1]

In addition, a variable such as nonlabor income would be
treated differently in a model of occupational choice in which the
household is not free to adjust hours of work at a given wage
rate. In a case where the individual can choose his hours of work
in a job given the wage rate offer, additional non-labor income
will reduce hours of work, assuming leisure or household
production time is a normal good. If each job offers a fixed
combination of hours of work and annual pay, additional non-labor
income will affect the individual's occupation choice, other
things being equal. Since he values leisure more at the margin
given the higher level of non-labor income, he may choose to
accept a position with lower annual pay, but fewer hours.
Because nonlabor income affects the value of leisure at the hours-
constrained margin, it is relevant to include its level in the
occupational choice specification, particularly when comparing the
choice of a specific alternative, such as reenlistment in the
Army, relative to a general alternative, such as a "civilian"
job.[2]

4.2 Labor Force Participation

A related point is that the indirect utility function
approach assumes an interior solution. It is assumed that both

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[1] Therefore, we would attempt to include variables indicative of
required hours of work (e.g., deployment time, time spent on
unaccompanied tours), variables that are likely to affect the
marginal value of time spent at home (e.g., family size, and home
ownership).

[2] A typical interpretation of the effect of non-labor income in
an occupational choice decision is that it affects the relative
valuation of non-pecuniary factors of a job relative to money
income. The same is true here with "hours of work" being a
specific non-pecuniary factor.

spouses participate in the labor market. Participation is a relatively innocuous assumption for the member spouse. However, for the nonmember spouse, the market wage may be so low, or, alternatively, the value of leisure so high, that she does not participate in the labor market, resulting in a corner rather than an interior solution.

The complications implied for our model of occupational choice are seen most clearly in the case where the nonmember spouse chooses not to participate in the labor market regardless of whether the member spouse remains in the Army. One might impute a difference in the potential market wage of the spouse for the two states, but since she is not participating in the labor market, this difference would not represent a difference in household utility.

Alternatively, if the nonmember spouse does not participate in the labor market in state A, but would participate in B, the difference in imputed market wages in the two states would overstate the difference in utility. This is because the marginal value of leisure (home production) in state A exceeds the imputed state A wage rate.[3]

The possibility of corner solutions on labor force participation of the spouse poses an impediment on the construction of a family ACOL variable that is analogous to the estimate of the financial opportunity cost of leaving military service used in models of retention based upon individual

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[3] Note that if the nonmember spouse does not participate in the labor market in state A, but does participate in B, one cannot necessarily infer that market wage opportunities are higher for the nonmember spouse in B. For example, if the member's hours of work are constrained in A, but less constrained in B, the member may be free to supply more hours of leisure (or household production time) in B, lowering the marginal value of the nonmember spouse's leisure time, and inducing her to participate in the labor market.

behavior.[4] One way of modifying the simple theory is to incorporate the dollar-equivalent value of household productivity. If both household members work in the labor market in both states, the wage rate of each is equal to the value of foregone household production (or foregone leisure) at the margin. However, whenever hours of work are constrained, either by fiat or by custom, the marginal value of leisure may differ from the wage rate.

Moreover, in the financial opportunity cost variable, the difference in potential earnings of the nonmember spouse in state B relative to state A is measured, given her characteristics, regardless of whether the spouse participates in the labor market.[5] For both of these reasons, one might attempt to include variables that affect the spouse's household productivity. If the spouse's household productivity is high relative to potential earnings in either state A or state B, then the difference in those earnings will be less relevant to the household's decision to remain in the Army than if expected household productivity were relatively small.[6]

Alternatively, a variable that indicates whether the nonmember spouse is a labor market participant in State A could be included. Such a variable would undoubtedly be correlated with the retention decision. However, the labor force participation variable is endogenous in a system describing the retention behavior. To an extent, the decision of the nonmember spouse to participate in the labor force and invest in job search may be

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[4] Smith and Goon (1987b) report that over 50% of the wives of male Air Force officers were not in the labor force at the time of the 1985 DoD Member and Spouse Surveys.

[5] Indeed, because of the tobit formulation of the labor supply curve (see sections 6 and 7), there is some positive, even if very small, probability that each spouse will work.

[6] The variable constructed to estimate the expected loss in spouse labor market rents attempts to capture differences in the value of home production or leisure time.

made jointly with the decision of the member to leave military service. Including variables that attempt to control for household productivity along with a variable that captures the nonmember spouse's market wage opportunities is equivalent to including a reduced form labor force participation equation in the retention model.

In section 3.3, we derived a measure of the expected change in net labor market rent. An exposition of how this measure can be used to solve this problem will be presented later in this section and in section 5.

4.3 Military Compensation System and a Household ACOL

The particular nature of military compensation is another reason why the wage rate, by itself, does not capture sufficient information for the occupational choice decision. For those completing at least twenty years of military service, a significant portion of total compensation is the military retirement annuity, a form of deferred compensation.[7] However, for those staying less than twenty years, the retirement system offers nothing.[8]

The twenty-year vesting point for military retirement makes earnings, a function of military service, highly nonlinear, with a quantum increase at the twenty-year point. This complicates the calculation of the appropriate financial incentive to remain in

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[7] For those entering before October, 1980, the retirement annuity from completing twenty years of service is 50% of the member's basic pay at the retirement point. For those entering between 1980 and 1986, the annuity is 50% of an average of the member's highest three years of basic pay -- typically his last three. Entrants after 1986 receive 40% of an average of their highest three years of basic pay.

[8] Officers, however, are eligible for severance pay under certain conditions.

military service because it will vary depending upon whether the horizon for calculating this incentive encompasses the twenty-year point. Moreover, it is clear that a simple, one-period model of occupational choice is inadequate to capture, in a theoretically rigorous manner, the effects of more complicated compensation systems.

It was precisely to solve this problem that the Annualized Cost of Leaving (ACOL) model was developed. The ACOL model makes the choice of horizon nonarbitrary by calculating the annualized difference between military and civilian pay (ACOL) over the horizon for which this difference is maximized.[9] The financial incentive to leave immediately is compared to the incentive defined by the optimal leaving point, conditional upon staying one more period.[10]

In a model of household decisionmaking, the problem is more difficult. The horizon that maximizes the annualized cost of leaving for the individual member is not necessarily the horizon that would maximize the cost of leaving for the household, when the earnings of the spouse are considered. In concept, one can consider a single household or family annualized cost of leaving defined to include the nonmember spouse's earnings. Because this approach seems like the natural "household" counterpart to the individual-specific ACOL, we derive a measure of the household annualized cost of leaving. Then, we discuss several problems with this measure in a household model of utility maximization.

Assume the household is making a retention decision at time period t. The "household" ACOL would be defined as:

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[9] See Black, Hogan and Sylwester (1987) for details of the ACOL calculation.

[10] It is interesting to note that the ACOL model was never formally derived from a model of utility maximization over the lifetime.

$$ACOL_H =$$

$$\max h \; \{ \sum_{i=1}^{h} \quad [(E^A_{m,t+i} + E^A_{f,t+i}) - (E^B_{m,t+1} +$$

$$E^B_{f,t+i})](1+r)^{-i}$$

$$+ \quad \sum_{j=h+1}^{T-t} \quad [(E^A_{m,t+j} \; E^A_{f,t+j}) - (E^B_{m,t+j} + E^B_{f,t+j})])(1+r)^{-i}$$

$$\times \; [\sum_{k=1}^{h} (1+r)^{-k}] \qquad\qquad (4.1)$$

where

$E^A_{m,t}$ is the member's earnings at time t assuming he stays h more periods before entering the civilian sector.

$E^A_{f,t}$ is the nonmember spouse's potential earnings at time t assuming the member spouse stays h more periods.

$E^B_{m,t}$ is the member's earnings at time t assuming he leaves immediately.

$E^B_{f,t}$ is the nonmember spouse's potential earnings at time t assuming the member leaves immediately.

T is terminal point for the household.

h (>0) is the number of additional years that the member would remain in the Army to maximize ACOL.

This definition of the "family ACOL" is exactly analogous to the ACOL in the model of individual decisionmaking and is related to the notion of labor market "rents".[11] The first bracketed expression is the difference in household earnings from remaining in the Army an additional h periods versus leaving immediately. Note that if the nonmember spouse's market opportunities are unaffected by the decision to remain in the Army, $E^A_{f,t+i} = E^B_{f,t+i}$, and the measure collapses to the financial cost of leaving variable from the individual model. Moreover, if both the member's and spouse's postservice opportunities are unaffected by

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[11] It is equal to "rents", however, only in the instance where there spouse would work the same hours in either state.

military service, the second bracketed expression is zero. This is the assumption that is usually made in retention analysis.[12] Though there is some empirical evidence that military experience is less than a perfect one-for-one substitute for civilian experience, there is no evidence on its affect on the nonmember spouse's earnings opportunities once the member leaves.

If the variables in equation (4.1) were measurable, one could calculate the optimal horizon, h, and a family measure of the financial opportunity cost of leaving military service that is the analogue to the ACOL variable from the retention model based upon individual decisionmaking. The retention decision rule would be

Stay if:

$$a_1 ACOL_H + e > 0 \qquad\qquad (4.2)$$

where $ACOL_H$ is the household annualized cost of leaving variable as defined by (4.1), e are unobserved factors affecting retention behavior,[13] and a_1 is a parameter to be estimated.[14] This model can then be estimated as a probit or logit equation.

However, there is a problem in interpretation. In order to combine the earnings of both spouses into one measure, it must be assumed that the marginal value of an additional dollar of income

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[12] The study by Black et al. (1987) is the only exception to this of which we are aware. It was assumed that the member's postservice earnings were affected by the mix of military and civilian experience, and, using results of an analysis of postservice earnings by Goldberg and Warner (1983), allowed the civilian earnings opportunities to shift as a function of the experience mix in the calculation of the individual ACOL.

[13] The error term may be interpreted as tastes or other omitted variables that are orthogonal to the other explanatory variables in the model.

[14] Other variables, such as nonlabor income and factors affecting production in the household, may also be included in this equation.

is independent of which spouse generates the income. While the marginal value of the income is independent of its source, the implications for the value of leisure and household production may differ significantly between the member and nonmember spouse.

In the formulation of (4.1) we assume that the member spouse is a full-time participant in the labor force in both state A and state B. However, we measure the nonmember's potential earnings -- what she would earn should she participate in the labor market in each state. As discussed in the previous section, this is not necessarily correct. For example, the financial cost of leaving variable may understate the incentive to remain in military service when the nonmember spouse is not participating in the labor market, because the value of the nonmember spouse's leisure time (or household production) exceeds the imputed potential earnings in state A; else, the spouse would have been working.

More generally, the leisure time of each spouse may not be perfect substitutes. In the direct utility function of equation (3.1), it is not necessarily the case that, holding X constant, $dU/dL_m = dU/dL_f$ when $L_m = L_f$. One spouse may have an absolute advantage in household production. The foregone value (leisure) of household production from working 40 hours per week in the labor market is greater for the spouse with the absolute advantage in household production. For this reason, it may be inappropriate to combine both spouses' labor market opportunities into a single ACOL variable, as in equation (4.1).[15]

Instead, separate coefficients representing household members' differences in household production and the value of

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[15] If hours of work for both the member and the spouse are constant and unchanging, the earnings opportunities of the member and spouse can be combined into a single measure because the leisure or household production foregone is assumed constant. The assumption of fixed hours of work is unreasonable, especially for the nonmember spouse.

leisure time should be estimated for each spouse. This suggests another equation.

Reenlist if:

$$a_1 ACOL_m + a_2 ACOL_f + e > 0 \qquad\qquad (4.3)$$

The horizon as defined in equation (4.1) will still be determined jointly by the household and may differ from the horizon for each individual member. The researcher must know the preferences of the household to calculate each ACOL. These are given by the parameters, a_1 and a_2, which the researcher is attempting to estimate in the first place. Hence, this specification would be difficult to estimate.

4.4 Nonpecuniary Differences

The simple model of occupational choice based upon household decisionmaking assumes that, if the individual can freely choose hours of work, he is indifferent between two jobs or occupations offering the same money wage. Obviously, this is not the case. Nonpecuniary aspects of the occupation influence the choice.

We can incorporate nonpecuniary factors into our theory of occupational choice in the following way. The dollar wage rate offered in a particular occupation contains a wage premium, if the job has disagreeable nonpecuniary characteristics, or a discount, if the occupation has attractive nonpecuniary conditions associated with it. This premium or discount is determined by the supply and demand for labor in the market. Individuals and households, when making an occupational choice, evaluate nonpecuniary differences and the compensating wage differentials (wage premia or discounts). They then choose an occupation representing a combination of wages, nonpecuniary characteristics, and nonwage compensation for which utility is the greatest.

In our model of the military retention decision, we will assume that the military member considers only full-time alternatives to service in the Army. The nonpecuniary aspects of service in a particular Military Occupational Specialty (MOS) are measured relative to a typical civilian alternative occupation. Hence, the household's decision is to remain in the military and accept the bundled package of pay, other benefits, and nonpecuniary conditions of service or enter the civilian sector and the occupation offering the best compensation package. To account for the nonpecuniary differences between the Army and alternative civilian occupations, we will include variables that vary by Army skill and reflect differences in working conditions across Army skills relative to the civilian sector.

4.5 A Revised Model

The simple household model of occupational choice applied to the Army retention decision assumes that the household chooses between remaining in the Army and entering the civilian sector based upon the differences in both the member and spouse wage offers in each state. Shortcomings of this formulation, due largely to institutional factors, are that it (a) ignores constraints in the choice of hours of work; (b) fails to account for the incentive provided by the military retirement system; (c) neglects the possibility of specialization in household production by the nonmember spouse (out of the labor force) and does not account for factors affecting household productivity; and (d) does not account for nonpecuniary differences in occupations. A revised model, presented below, attempts to mitigate these problems.

The revised model will adopt a life cycle utility function to derive the optimal horizon, in a manner similar to ACOL. It will include additional variables to account for nonpecuniary

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differences in occupations and account for the loss in nonmember spouse earnings in a theoretically appropriate manner.

4.5.1 Measuring the Loss In Spouse Labor Market "Rent" Due to Military Life

One of the major analytical problems is how to measure the loss the family suffers due to the effect of military life on the nonmember spouse's employment opportunities. The difficulty arises because the spouse may choose to allocate different amounts of time to the labor market depending upon her opportunities. In particular, a nonmember spouse may choose not to participate in the labor market while the family is in the military, but may reenter should the member leave. The spouse's earnings when the family enters the civilian sector clearly overstates the incentive to leave arising from this source because it ignores the value of leisure time, or "nonmarket productivity", the family enjoys when the spouse is not working.

We solve this problem by estimating a structural labor supply curve for the nonmember spouse and a structural wage equation. The effects of military life on spouse earnings opportunities are captured by variables, such as frequency of PCS moves, that are included in the spouse wage equation. By setting these at military and civilian levels we are able to estimate the difference in the spouse's wage rate.

Our measure of the net effect of military life on the spouse's market opportunities is the difference in the "rent" she enjoys from the labor market in each state. We evaluate the labor supply curve of the spouse at the wage rate she can expect in the military and the wage rate that can be expected if the family decides to leave the military sector, compute the "rent" or producer surplus in each case, and calculate the difference. Consider the following diagram.
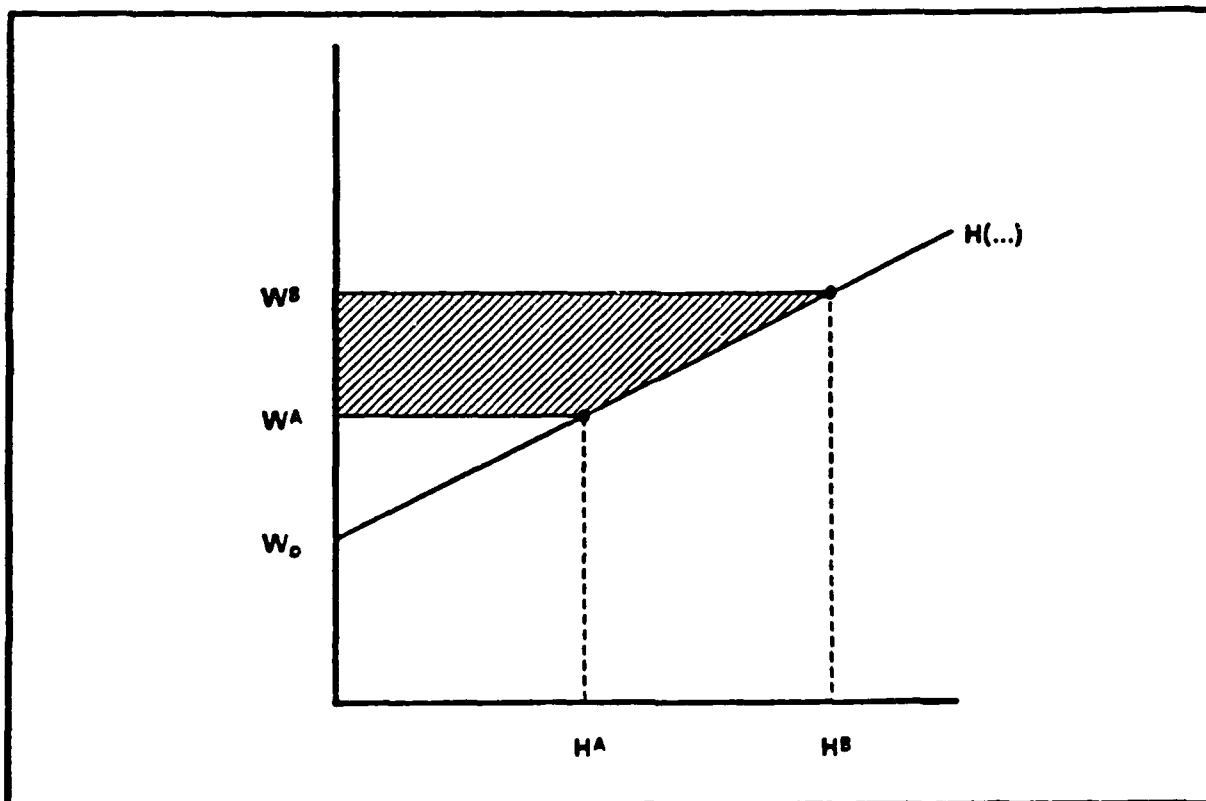
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FIGURE 4.2:   LOSS IN SPOUSE LABOR MARKET RENTS

The supply curve, H, shows the number of weeks the spouse
would choose to supply to the market each year, given the wage
offer. Spouse characteristics and factors affecting the spouse's
nonmarket productivity, or value of leisure time, are held
constant along the curve.[16] The rising supply price of labor,
then, reflects an increasing marginal value of leisure time, as

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[16] The supply curve contains a shift parameter indicating the
direct effect of a PCS move on weeks worked. The interpretation
is that a PCS move temporarily increases the value of home
production, or the value of leisure time, for the spouse who is in
the military. In the discussion that follows, we evaluate the
supply curve assuming that the PCS shift parameter is set to zero,
and then add back in the effect of a PCS move, on average, on
weeks worked, evaluated at the wage rate while in the civilian
state.

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theory would predict. The area under the curve up to a given quantity of weeks supplied to the market approximates the nonmarket value of those weeks to the family--the opportunity cost.

At wage W_B, the spouse would supply H_B weeks to the market, while at wage W_A, the nonmember spouse would supply H_A weeks. The net cost of foregone rents from state A relative to state B is given by the shaded area. This is the measure we will include in the retention model to represent the net loss to the family due to the effect of military life on nonmember spouse opportunities.[17]

Note that if the spouse has a predicted wage rate below W_0 while in the military, but above W_0 if in the civilian sector, the loss is computed as the area under the wage line but above the supply curve at the civilian sector expected wage and weeks worked. This estimate lessens the need to include variables correlated with the home productivity of the spouse, because the value of leisure is implicitly subtracted from the gross expected earnings loss of the spouse. However, such variables may be included to determine if home productivity is state dependent-- that is, if it varies depending upon whether the household has entered the civilian sector or remained in the military. They may also capture the effects of military benefits that vary with household characteristics. Commissary discounts, for example, may be worth more to larger families.

If the spouse were employed in both states, we can specify the a particular indirect utility function as :

$$U^A{}_t = Y^A F_t + a_1 W^A{}_{m,t} + a_2 W^A{}_{f,t} + e_a \qquad (4.4)$$

where $Y^A F_t$ is "full" income defined as $W_m T_m + W_f T_f + Y_n$; T_m and T_f are total time available and Y_n is nonlabor income.

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[17] See, however, the previous footnote.

We assume that the member will work a fixed number of hours in either state. Unfortunately, however, we must account for the possibility that the spouse may not be working in one or both states, or that hours of work may differ between states. One way to accommodate this possibility is to incorporate variables affecting the probability of being employed into the equation-- that is, variables affecting the labor force participation rate. Instead, we include a measure of the the expected difference in spouse labor market rents between states A and B directly.

Assume, at time t, the soldier and his family are deciding whether to stay in the Army at least one more period or to enter the civilian sector. Let the yearly value of household utility from remaining in the Army be given by:

$$U^A{}_t = a_1 E^A{}_{m,t} + a_2 R_{A,t} + X_{np} B_{np} + X_1 B_1 \qquad (4.5)$$

where

$E^A{}_{m,t}$ is the earnings of the member spouse in year t if he remains in the Army for h more periods.[18]

$R_{A,t}$ is the estimated spouse labor market rent, our measure of the value of spouse employment to the household, if the member remains in the Army for h more years beyond period t.

X_{np} is a vector of variables attempting to capture the nonpecuniary conditions of service in the Army for the household. These are assumed to remain constant as long as the soldier remains in the Army and are measured relative to

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[18] Here, h is the optimal horizon, as defined previously. We define earnings this way so that civilian earnings of both the member and the spouse can vary with the mix of military and civilian experience as well as total experience. Hence, the potential civilian earnings of the household for state A are conditional upon staying at least h more periods. In general, the earnings will differ from the potential civilian earnings the family would enjoy in that calendar year if they were to leave immediately (State B) because their mix of military and civilian job experience differs in the two states.

the civilian sector nonpecuniary conditions of employment.
Hence, they are zero while in the civilian sector.

X_1 is a vector of factors affecting the household's
evaluation of leisure time, including nonlabor income and
variables affecting the productivity of leisure time.
Because it is assumed that Army life places greater
constraints on hours of work than do civilian alternatives,
these are included in the state A case to control for
differences in the opportunity cost of leisure time while the
member is in the Army.

e is an unobservable error component representing the
household's taste for Army life. It is assumed to remain
constant while the household remains in the Army.

The annual value of household utility while in the civilian
sector, state B, is given by:

$$U^B_t = a_1 E^B_{m,t} + a_2 R_{Bt} \qquad (4.6)$$

where

$E^B_{m,t}$ is the annual earnings of the member at time t if he
enters the civilian sector immediately.

R_{Bt} is the estimated labor market rent, our measure of the
value of spouse employment to the household, if the member
were to leave the Army immediately.

The household's decision rule, then, is to stay at least one
more period if there is a length of time for staying in the Army,
a horizon h, for which

$$\left(\sum_{i=1}^{h} (U^A_{t+i} - U^B_{t+i})(1+r)^{-i} \right) +$$

$$\left(\sum_{i=h+1}^{T-t} (U^A_{t+i} - U^B_{t+i})(1+r)^{-i} \right) > 0 \qquad (4.7)$$

In this equation, r is the household's marginal rate of time
preference which is also equal to the rate at which the household

can borrow and lend. T is the point at which the household
dissolves.

Assume that the difference in spouse labor market rent
between state A and state B is constant over time while the member
is in the Army and disappears when the member leaves the military.
That is, the spouse's wage opportunities are not permanently
affected by the family's length of stay in the Army. Under this
simplifying assumption we can write the decision rule as,

Stay, if there is at least one time horizon, h, for which:

$$\left\{ \sum_{i=1}^{h} a_1 (E^A_{m,t+i} - E^B_{m,t+i})(1+r)^{-i} + \sum_{i=h+1}^{T-t} a_1 (E^A_{m,t+i} - E^B_{m,t+i})(1+r)^{-i} \right\} / \left(\sum_{i=1}^{h} (1+r)^{-1} \right)$$

$$> -(a_2 (R_{A,t} - R_{B,t}) + X_{np}B_{np} + X_1 B_1 + e_a)$$

$$(4.8)$$

The expression on the left-hand side of the inequality is the
difference in the earnings for the military member that results
from staying h more periods rather than leaving immediately,
annualized over h periods. The inequality implies that the member
will reenlist if this annualized difference is greater than the
expression in brackets on the right of the inequality. Note that
this difference in earnings could include the effects of the
military retirement annuity, if h encompasses the twenty-year
vesting point for retirement.

We do not know the household's optimal length of stay, which
depends upon both the observable variables in the inequality and
the unobservable component, e. But we can compute the length of
stay, h, that maximizes the expression on the left-hand side. If
the household is unwilling to stay for the period for which the
annualized difference in earnings is greatest, it will be

unwilling to stay for any other positive time horizon. This
index function, then, becomes the appropriate measure of the
financial incentive to stay. Maximizing the left-hand side with
respect to h results in a variation of the Annualized Cost of
Leaving.

We can rewrite the inequality as stay if:

$$a_1 \, ACOL_m + a_2 (R_{A,t} - R_{B,t}) + X_{np} B_{np} + X_1 B_1 > e \qquad (4.9)$$

Assuming that e is distributed normally with mean zero, we can
estimate the model as a probit. We hypothesize that $a_1 > 0$ and
$a_2 > 0$.

4.6 Summary and Outline of the Remainder of the Report

In sections 3 and 4 the development and exposition of a
theory of household retention behavior was presented. Section 3
emphasized a relatively rigorous theoretical development of the
concept of labor market rents, or producer surplus, and how the
financial variables in the reenlistment equation could be
reinterpreted in a manner consistent with this concept. A major
advantage of this approach is the ability to estimate the welfare
effects of a change in wage opportunities when the quantity of
labor supplied also changes in response to the difference in wage
rates.

In section 4, ways in which the model could be adapted to
capture key institutional aspects of Army service were presented.
These included a discussion of the implications of fixed hours of
work, spouse labor force participation, nonpecuniary factors, and
the military compensation system for a model of household
retention behavior. A life-cycle version of a household
reenlistment model was developed that integrated the notion of
labor market rents, developed in section 3, with the more

traditional Annualized Cost of Leaving (ACOL) model that is prominent in the economics literature on military retention behavior.

The results from estimating a quasi-reduced form version of the retention model developed in sections 3 and 4 are presented in section 7. In section 5, a three equation model of spouse labor supply is presented. It is from this model that we compute the expected change in spouse labor market rents if the family were to leave the Army and enter the civilian sector. The results of estimating the model are presented in section 6, and the change in rents, or producer surplus, is calculated. This measure becomes a variable in the reenlistment equation presented in section 7.

5.0 A STRUCTURAL ESTIMATE OF THE EFFECT OF MILITARY LIFE ON SPOUSE EARNINGS

A key element in the household model of the reenlistment decision we have developed is the effect that military life has on the wages, or potential wages, of the nonmember spouse. The frequent rotation of the military member and the limited choice in assignment location are hypothesized to impose a cost on the potential earnings opportunities available to the spouse. Measurement of this cost is not straightforward, however.

In this section, we present a method by which we estimate the dollar equivalent value of the welfare loss suffered by the Army family due to the effect of military life on the earnings of the nonmember spouse. Our structural estimate is based upon the effect of military life on "labor market rent", a concept developed in Section 3.3. In this section we outline the mechanics of obtaining such a measure. We will briefly outline the entire procedure verbally in section 5.1, then present each part of the analysis more rigorously in subsequent sections. In section 6 we will present the empirical results.[1]

5.1 Method for Estimating Spouse Earnings Loss: Overview

Data. Our procedure for estimating the effect of military life on nonmember spouse earnings uses data from the 1985 DoD Member and Spouse Survey.[2] The Survey contains data on the earnings and weeks worked of the spouse in 1984. Data concerning factors potentially affecting earnings, such as the average cumulative time the spouse was at her 1984 location, and whether

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[1] The casual reader may consider glancing through sections 5.1 and 5.4, and then proceed to the empirical results in section 6.

[2] At the outset, it should be noted that our data set is limited to the 1985 DoD Member and Spouse Survey. The scope of our effort precluded the analysis of additional data sets.

the military family had a PCS move in 1984, are also available. Finally, the usual demographic factors are also found in the survey.

Three Equation System. The spouse labor supply model is a three equation system:

$$\ln r = X_r A^* + e_1 \tag{5.1}$$

$$\ln W^A = X_w B^* + e_2 \tag{5.2}$$

$$H^r = g_1 \ln W^A + X_H^* G^* + e_3 \tag{5.3}$$

Equation (5.1) is the natural logarithm of the reservation wage, $\ln r$. The reservation wage can be interpreted as the (marginal) value of nonmarket time or time spent in home production. Equation (5.2) describes the spouse's weekly wage rate while in the Army, W^A, as a function of the spouse's human capital, and other factors. Equation (5.3) describes number of weeks worked by the nonmember spouse while the family remains in the Army, H^A. It is the spouse's labor supply equation and is a function of the spouse's market wage, and other variables. In these equations, X_r, X_w, and X_H are vectors of factors affecting the reservation wage, the spouse's market wage, and weeks worked, respectively, while A^*, B^*, and G^* are associated vectors of coefficients. Individual subscripts are suppressed.

Included in the reservation wage equation are variables that affect the value of the spouse's nonmarket time, such as the number of children and the presence of pre-school age children. The wage equation includes human capital variables expected to affect the spouse's wage offer, such as education and experience, but also variables intended to capture the effects of military life on the spouses market wage, such as average tenure at a location. Finally, the labor supply equation includes factors affecting the spouse's supply of labor to the market, such as the

variables affecting the reservation wage, the expected wage predicted from the wage rate equation, and "military life" factors, such as a PCS move.

The expected loss in spouse labor market rent from remaining in the Army is estimated using both the wage and labor supply equation. The spouse's expected wage rate is predicted both if family remains in the Army, and if they choose to leave. Then, this is included in the labor supply equation, and the expected loss in labor market rents is calculated.

Estimation. Equations (5.1) and (5.2) are combined to estimate the probability of working, or employment probability. The nonmember spouse will work if her market wage offer exceeds her reservation wage, the value of time in nonmarket activities. The probability of working is, therefore, Prob ($W^A > r$). This equation can be estimated as a probit. The wage equation is estimated, and the expected spouse wage is used as an explanatory variable in the labor supply equation.

The reason we estimate the probability of working equation is so we can obtain unbiased parameter estimates in the wage equation. Naturally, wage data is available only for those spouses who worked during the year. Theory and common sense suggest that those who have relatively high wage offers are more likely to work than those who face relatively low offers, all else being equal. Hence, those who work are a self-selected sample and, on average, probably have higher wage offers than the population as a whole. If the wage offers are affected by factors unmeasured by the researcher, and factors affecting the wage are correlated with variables that are measured in (5.2), the estimated coefficients in (5.2) will be biased.

The error in the probability of working equation is likely correlated with the unmeasured factors affecting the spouse wage This is so because, for example, the probability of working is a

function of the wage offer. Hence, including a transformation of the expected probability of working as a variable in (5.2) will capture the effects of the unmeasured variables, resulting in unbiased estimates of the remaining coefficients.[3]

The labor supply equation, equation (5.3), is estimated as a "two-limit" tobit. There are two truncation points, one at zero weeks worked and one at 52 weeks worked. The two limit tobit explicitly accounts for the probability mass at these two points. The wage rate is endogenous in this system. Hence, the wage rate in (5.3) is the expected wage rate, estimated from the adjusted wage rate equation (5.2).

The system is estimated in three stages. The first two consist of the Heckman two stage procedure for obtaining an unbiased estimate of the wage rate equation. The last step is a two-limit tobit estimate of the labor supply equation with an estimate of the spouse's expected wage estimated from equation (5.2).

A structural estimate of the dollar value of the welfare loss due to the effects of military life on spouse labor market opportunities is calculated from the wage and labor supply equations. An estimate of the expected wage is obtained from the wage rate equation under the assumption that the family remains in the Army, and under the alternative assumption that it leaves. The difference in wage rates implies a difference in expected weeks worked for the spouse in the two states. This is calculated from the labor supply equation. The expected loss in labor market rent is then estimated from these points. Finally, the cost of

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[3] The variable included in the wage equation is the inverse Mill's ratio. It is calculated from the probability of working equation. It is equal to the ratio of the probability density to the cumulative distribution of working, evaluated at the value of the explanatory variables relevant to each spouse.

the expected number of weeks of work lost (annually) that is directly due to PCS moves is added to this measure.

An advantage of this specification is that military spouses serve as their own control group. Attempting to infer what a military spouse can potentially earn should the family leave the Army by considering ostensibly similar "civilian" spouses is subject to significant sample selectivity bias. A better approach would be to follow those military families who leave and measure subsequent spouse earnings. If this were possible, the difference in the spouse wage rates due to military life could be inferred directly from the actual wages of spouses whose family had left active Army service. This, too, would be subject to sample selectivity bias but of a sort that can be reduced statistically through a method analogous to that used for estimating a wage equation.

5.2 Spouse Probability of Working Equation

We can identify three cases for analyzing the probability of working. Let r be the reservation wage of the spouse when no time is allocated to the labor market, W_A the wage rate offered to the spouse should the household remain in the military, and W_B the wage rate available to the spouse should the household leave the military and enter the civilian sector. We presume that $W_A \leq W_B$. Then, the first case is:

$$\text{Case 1:} \quad r < W_A \leq W_B$$

In this case, the spouse will work in both state A and state B. The difference, $W_B - W_A$, represents a relevant earnings loss per weeks worked from remaining in the military.

In the second case:

$$\text{Case 2:} \quad r > W_B > W_A$$

The effect that military life has on the spouse's earnings opportunities is irrelevant, because the spouse would not participate in the labor market in either case.

Finally, if:

$$\text{Case 3:} \quad W_B > r > W_A$$

The spouse would choose not to participate, if the household remains in the military, but would participate at the higher wage rate available if the household leaves the military.[4] In this case, W_B-W_A overstates the relevant earnings loss per hour worked. A better estimate is W_B-r, but, of course, the reservation wage is difficult to observe.[5]

Our data, from the 1985 DoD Member and Spouse Survey, contains earnings from spouses who worked in calendar year 1984. To infer potential wages of the entire population of spouses based only upon those who worked in calendar year 1987 may result in biased estimates. Those who worked, may have had unusually high market wages, unusually low reservation wages or both, due to factors unobserved by the researchers.

To understand the potential problem, consider the following simple model. Let the log of the reservation wage for a given spouse, lnr, be given by:

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[4] We ignore the possibility that the reservation wage is state dependent.

[5] We can, however, estimate r from the labor supply equation discussed in the next section.

$$\ln r = X_r A^* + e_1 \qquad (5.4)$$

The potential market wage is specified as:

$$\ln W = X_w B^* + e_2 \qquad (5.5)$$

The military spouse will work, and we will observe earnings in 1984, only if: .

$$\ln W^A > \ln r$$
$$\text{or}$$
$$\ln WA - \ln r > 0 \qquad (5.6)$$

The military spouse will work in the market only if:[6]

$$X_w B^* - X_r A^* > (e_2 - e_1)$$
$$\text{or}$$
$$(e_2 - e_1) > - [X_w B^* - X_r A^*] = -(XC^*)$$

Therefore, we define an index function such that the individual will participate ($y = 1$) if:

$$XC^* + (e_2 - e_1) > 0$$
$$\text{or}$$
$$XC^* + V > 0 \qquad (5.7)$$

where $V = (e_2 - e_1)$

Now, when equation (5.2) is estimated for spouses for whom earnings are observed, we have:

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[6] It is not the case that all variables in the reservation wage equation are also in the market wage equation. For convenience, it may be assumed that both A and B contain coefficients that are zero, and are constrained to be zero during estimation. In that case the notation can be simplified to become

$$\ln r - \ln W = [X_w B^* - X_r A^*] = X_r (A^* - B^*) = (XC^*)$$

$$E[\ln W] = XB^* + E[e_2 | e_2 - e_1 > -(XC^*)]$$

$$= XB^* + E[e_2 | V > -(XC^*)]$$

$$= XB^* + COV(e_2, V) \, E[V | V > -(XC^*)]$$

$$= XB^* + \frac{(Se_2^2 - COV(e_2, e_1))}{Sv} \text{lamda}$$

$$= X_i B^* + \frac{Se_1 Se_2}{SV} \left(\frac{SvSe_2}{Se_1} - Rho\right) \text{lamda} \qquad (5.8)$$

$$\text{where lamda} = \frac{f(-XC^*)}{F(-XC^*)}$$

Rho is the correlation between e_2 and e_1, and $F(\ldots)$ and $f(\ldots)$ are the cumulative distribution and the probability density functions of e.[7]

The procedure for estimating (5.8), due to Heckman (1976), is to estimate, first, equation (5.7) as a probit. Then, for each spouse that worked, estimate the wage equation using the inverse Mills ratio, lamda, to adjust for the selectivity that may potentially bias the population inferences.

5.3 Labor Supply

The labor supply equation is given by:

$$H_i = gE[\ln W_i] + GX_{Hi} + e_3 \qquad (5.9)$$

For the wage rate, $\ln W_i$, we substitute the expected wage rate, based upon the nonmember's spouse's characteristics from equation (5.8). Approximately 48% of our sample reported no weeks

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[7] "S_e" denotes the standard deviation of random variable e, and COV(,b) is the covariance of variables a and b.

worked in 1984, while 12% reported that they worked 52 weeks. Both of these represent truncation points. Hence, we employ a "two limit" tobit in our estimation procedure.

The stochastic model underlying the two limit tobit becomes:

$$H = gE[lnW] + X_H G^* + e_3 \quad \text{if } 0 < gE[lnW] + X_H G^* + e_3 < 52$$

$$H = 0 \quad \text{if } gE[lnW] + X_H G^* + e_3 < 0$$

$$H = 52 \quad \text{if } g[ElnW] + X_H G^* + e_3 > 52$$

Then, the expected value of H is:

$$E(H) = F\left(\frac{-gE[ln_W] + -GX_H G^*}{Se}\right) \cdot 0 +$$

$$+ [F(52 - gE[lnW] - X_H G^*) - F(-gE[lnW] - GX_H G^*)] [gE[lnW] + X_H G^*]$$

$$+ \frac{Se_3 \ [f(-gE[lnW] - X_H G^*) - f(52 - gE[ln_W] - X_H G^*)]}{F[52 - gE[lnW] - X_H G^*] - F[-gE[lnW] - X_H G^*]}$$

$$+ (1 - F[52 - gE[lnW] - X_H G^*] \cdot 52$$

or

$$E(H) = [F(52 - gE[lnW] - X_H G^*) - F(gE[lnW] - X_H G^*)](gE[lnW] + X_H G^*)$$

$$+ Se_3 (f(-gE[lnW] - X_H G^*) - f(52 - gE[lnW] - X_H G^*)$$

$$+ (1 - F(52 - gE[lnW] - X_H G^*) \cdot 52$$

In words, the expected weeks worked is equal to the sum of:

> (1) the probability of working more than zero weeks, but less than 52 weeks, multiplied by the expected weeks worked conditional upon falling in that interval, which included the expectation of the error term conditional upon falling in that interval;

> (2) the probability of working 52 weeks, multiplied by 52.

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In the two limit tobit case, the change in expected weeks worked with respect to the wage rate consists of three parts: (1) the effect that an increase in the wage has on the probability of working; (2) the effect that the wage has on weeks worked, conditional upon already working; and (3) the effect that the wage has on the probability of working 52 weeks. Hence, the coefficient on the wage alone, g, is not the sole determinant of the response of supply to a change in the wage.

Identifying variables in this system include variables that affect the participation decision, but not the wage rate, such as number of dependents. Variables that affect weeks worked but not wage rate such as making a PCS move in 1984, also help identify the system.

5.4 Measuring the Spouse's Loss Due to Military Life

The purpose of estimating the spouse wage equations and the labor supply curve is to compute the effect of military life on spouses earnings. However, the loss in which we are interested is not simply the spouse's expected earnings while the family is in the Army relative to earnings should the family enter the civilian sector. This measure would, typically, overstate losses because it ignores the spouse's value of non-market time.

For example, assume that the spouse does not work while the family is in the Army, but would work at wage W_B and weeks H_B if the family were in the civilian sector. Clearly, $W_B H_B$ overstates the loss because the spouse could have worked at wage rate W_A for H_B hours. What, perhaps, is somewhat more subtle is that $W_A H_B - W_B H_B$ also overstates the loss. The reason is that the spouse, by choosing not to participate in the labor market, has revealed that the value of her "home production", so to speak, is greater than $W_A H_B$.

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The correct measure of the difference is the loss in "rent" or producer surplus that the spouse suffers from being a part of a military family. Recall equation (5.9), the spouse's supply curve of weeks worked. Holding constant for individual i all factors affecting the supply of labor to the market except the wage, we can depict the supply curve as:
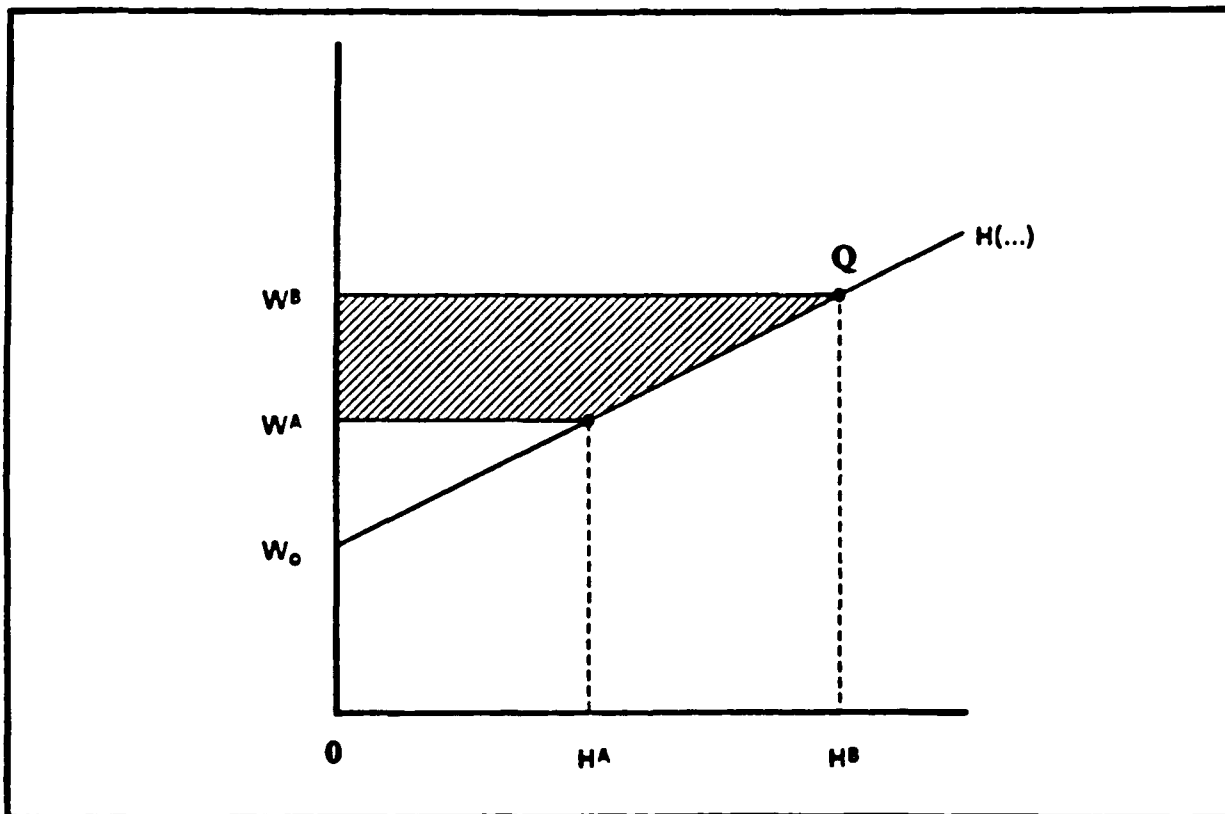
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FIGURE 5.1: LOSS IN SPOUSE LABOR MARKET RENTS

The net benefit to the spouse of being able to work at wage rate W_B compared to a case of not working at all is given by the triangular area $W_B W_0 Q$. The spouse's total earnings are given by the area $W_B Q H_B 0$, but the value of leisure time foregone -- "home productivity" -- is given by the area under the supply curve, $W_0 Q H_B 0$.

This simple diagram, based upon our estimated labor supply curve from equation (5.9) suggests the appropriate measure of the cost imposed upon the military family through the effect on spouse's labor market opportunities. It is, in fact, the loss in consumer surplus or labor market rent that we derived in section 3.3. A measure of the loss due to remaining in the military (state A) rather than leaving for the civilian sector (state B) is approximated by:

$$\text{Spouse Loss} = (W_B - W_A) H_A + 1/2 (W_B - W_A) (H_B - H^A)$$

If, on the other hand, the spouse's reservation wage is above her market wage while in the military the loss is approximated by:

$$\text{Spouse Loss} = 1/2 (W_O - W_B) H_B$$

Note, again, that the net loss is not $W_B Q H_B O$, because $W_O Q H_B O$ represents the value of leisure foregone.

Since we have estimated a structural supply equation, we will be able to approximate the loss in spouse's "rent" due to the military by evaluating the wage equation and the supply curve for each spouse, with and without the variables we can measure that adversely affect market opportunities while in the military.

A key assumption of this approach is that the wage rate the nonmember spouse would enjoy should the family leave the military can be inferred by setting the variables that adversely affect the nonmember spouse's wage, such as frequent moves, at an appropriate "civilian" value, such as zero. This is equivalent to assuming that we have captured the major determinants of the spouse's wage

rate in the equations, and that variation of PCS frequency, etc., within the sample population of military spouses is sufficient to identify the factors that make her wage while in the Army different from her wage should the family leave the Army.

6.0 ESTIMATION OF THE SPOUSE LABOR SUPPLY CURVE

In this section the results of estimating the nonmember spouse wage and labor supply equation are presented. Through these equations, the effects of frequent moves and other factors of military life on spouse earnings opportunities can be assessed and the expected loss in "labor market rents" calculated.

The section is outlined as follows. Section 6.1 is an overview of the 1985 DoD Member and Spouse Survey. This survey is the major source of data for this portion of the project.[1] Section 6.2 discusses the dependent variables in the estimation of the spouse wage and labor supply equation while the explanatory variables are defined in section 6.3. Descriptive cross-tabulations are in section 6.4. The parameter estimates for the wage and labor supply equations are presented and discussed in section 6.5. Finally, the method for calculating the expected loss in spouse labor market rents from the wage and labor supply equation is presented in section 6.6.

6.1 Overview of 1985 DoD Member and Spouse Survey

The primary data source for this project is the 1985 DoD Member and Spouse Survey. The DoD Survey provides sufficient information necessary to specify and estimate models of spouse earnings, labor force participation, and labor supply. In addition, with certain assumptions and limitations, the data is sufficient to estimate the effect of military life on spouse earnings. Finally, the DoD survey asked members to assess their probability of reenlisting. Such information, while less satisfactory than data on actual behavior, is sufficient to estimate a reenlistment equation, presented in section 8.

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[1] Limitations in the scope of the effort precluded pursuing other data bases.

The 1985 DoD Surveys consist of two major portions - the 1985 Member Survey (a world-wide survey of 132,000 active-duty officer and enlisted personnel) and the 1985 Spouse Survey (survey of the spouses of all married members selected for the Member survey).

The Member Survey was administered at the unit level to a stratified random sample during the first six months of 1985. Most of the surveys were completed between late February and March 1985. The total sample consists of 25,432 officer and 106,575 enlisted personnel. The number separating from the military between the 30 September selection date and administration was 7,417 (806 officers and 6,611 enlisted), leaving an effective sample of 124,590 (24,646 officers and 99,964 enlisted)[2]. After these adjustments, final response rates were 76.8 percent for officers and 70.1 percent for enlisted personnel. In the Army, the response rates were somewhat lower, 65% and 59% for officers and enlisted members respectively. The Member Survey is divided into nine sections: military information; present and past locations; reenlistment/career intent; individual and family characteristics; military compensation; benefits and programs; civilian labor force experience; family resources; and military life.

Spouse surveys were mailed to a sample of 73,912 (16,493 spouses of officers and 57,419 spouses of enlisted personnel). Data collection began in February 1985 and ended in July. The majority of the surveys were filled out in March, April, and May. Response rates were 70.56 percent for spouses of officers and 51.71 percent for spouses of enlisted personnel. The spouse questionnaire covers six major topics: the military way of life;

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[2] These figures reflect the entire number of personnel surveyed and may not be indicative of the number of valid responses to a specific questionnaire item on the survey.

family military experience; family programs and services; background; and paid work experience.

The Defense Manpower Data Center (DMDC) provided SRA with data as well as documentation from the 1985 DoD Surveys. The specific data set was a DMDC couples file consisting of all survey information from married personnel matched with survey information from their respective spouses. Therefore, an individual record contains "duplicate" data if both the Member and Spouse Surveys are available. The record contains only Member data if the spouse did not participate in the Spouse Survey. The DMDC files also contain special variables constructed from survey information (e.g., a single variable for number of children) and information added to each record from the master files (e.g., pay data).

With a plethora of information available from the DoD Surveys, we proceeded to extract relevant data and create a refined sample for analysis. The initial decision was to choose between the two separate survey instruments -- the Member Survey and the Spouse Survey. After developing preliminary models with data from both questionnaires, we decided to use data from the Member Survey. While the Spouse Survey collects information directly from the spouse, response rates are significantly lower relative to the Member Survey. The Member Survey also provides more accurate military information and serves as a reasonable proxy for spouse information. For these reasons, the Member Survey generates higher quality data.

Because our task is to estimate a model of Army retention behavior, the first data filter was to select only Army personnel. Of the four services, the Army accounts for 24,195 observations on the survey, or about 27 percent.

We also limit the analysis to enlisted personnel and their spouses. The Member Survey contains 70,025 enlisted or 79 percent

of the total sample. The retention patterns of enlisted members
and officers are very different. Although analysis of the officer
community would provide valuable insight, resources limit our
efforts to a single population. Enlisted service members
outnumber officers by almost 4:1, their spouses are more likely to
be wage earners, and their reenlistment decisions are better
defined than officers. For these reasons, we focus on the
enlisted community.

Additional selection criteria included gender and marital
status. Since both the member and spouse are essential to this
analysis, we consider only married personnel. Marital status is
defined as married, remarried, or separated (other choices on the
questionnaire are single, widowed, or divorced). About 66 percent
of all personnel surveyed are married (58,978 observations).
Furthermore, we narrow the married community to include only male
service members with civilian wives. We want to understand the
behavior of the "traditional" military family before proceeding to
more difficult cases.

The total number of observations in the Member Survey who are
Army enlisted males with civilian wives is 7,509. Data from these
individuals is used to estimate models of spouse labor supply and
family reenlistment behavior.

6.2 Dependent Variables in Spouse Labor Supply Analysis

The analysis of spouse labor supply consists of a set of
three equations: a probit model on the probability of spouse
labor force participation, a wage equation adjusted for sample
selection bias, and a tobit supply equation describing weeks
worked.

The dependent variable in the probit equation is a
categorical expression of employment of the spouse. There are two

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questions[3] available from the survey used to define "working":

> 94. In 1984, how many weeks did your spouse work for pay, either full- or part-time, at a civilian job, not counting work around the house?

> 95. Altogether in 1984, what was the total amount, before taxes and other deductions, that your spouse earned from a civilian job or his or her own business?

If the spouse works zero weeks or earns no money in 1984, then the dependent variable is coded as zero (non-worker). If the spouse works and reports positive earnings,[4] then she worked in the labor market and the dependent variable is coded as one.

The employment rate, the proportion of the spouse sample that worked in the market in 1984, is 0.5214. Slightly more than half of all wives of Army male enlisted personnel worked.

For the earnings equation, the dependent variable is the natural logarithmic value of spouse weekly wages. Responses from the spouse earnings question are divided by the number of weeks worked to derive weekly wages, and the logarithm is calculated. Our criterion for defining "work" is positive earnings.

For the labor supply equation, the dependent variable is simply the number of weeks worked in 1984. Among all individuals the mean is 16 weeks worked.

The labor supply model is developed as a two-limit tobit equation with a lower limit at 0 and an upper limit at 52. Approximately 53 percent of the sample does not work at all, while

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[3] All numbered questions refer to the enlisted personnel questionnaire on the DoD Member Survey.

[4] Spouses with greater than $2000 in reported weekly earnings are eliminated from the measure of participation. This magnitude of the earnings is implausible, and an indication of data entry error.

12 percent works the maximum 52 weeks per year. The mean number of weeks worked in the sample, conditional upon working, is 29.

Average hours of work per week are not reported in the survey. This is a shortcoming in the data in that part time and full time earnings cannot be distinguished.[5] We employed a number of different filters in an attempt to make this distinction. One alternative was to isolate full-time workers through a screen on wages. Those who had average weekly earnings that were greater than $134 (the minimum wage for a forty hour week) were defined as "full time". However, preliminary tests of these "full-time" models were unsuccessful and we decided to include all wage earners in the wage and labor supply equations.

Another related difficulty is to separate data from 1984 and 1985. Most questionnaire items ask for data that is current at the time of survey administration (January - June 1985). However, the items on wages reflect data from the previous year (1984). In some instances, events of 1984, the year for which earnings and weeks worked are reported, are imputed based upon the responses at the time of the survey.

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[5] There is a question in the survey concerning "current" labor market status that permits a distinction between "full time" and "part time" work. There are two problems with using this question to make this distinction in our analysis. First, the question asks labor market status at the time of the survey, and not the status during 1984, the year for which earnings are reported. Approximately 30% of the sample moves each year, affecting the probability that status at the time of the survey may differ from status in 1984. Second, the question makes only a categorical distinction between full and part time work. Hours of work per week are not reported.

6.3 Independent Variables in the Labor Supply Model

The labor supply model consists of three equations: (1) an equation estimating the probability of working; (2) an equation estimating the expected spouse weekly wage; and (3) the labor supply equation, predicting the expected weeks of work conditional upon the estimated wage and other factors. In general, there are two kinds of variables in the model: those variables that affect the spouse's value of non-market time or reservation wage, and those that affect the spouse's market wage.

Variables affecting the spouse's value of home production or leisure time include:

● the number and age of children

● the earnings of the member and non-labor income

● the amount of time the member spends away from the home (family separation)

The interpretation of these variables should be straightforward. The presence of children, especially young children, increases the spouse's opportunity cost of working in the market. Leisure, or non-market time, is assumed to be a normal good, so that family income, excluding the spouse's income, should increase the spouse's reservation wage. Finally, family separation will affect the reservation wage but the direction depends upon whether member and spouse time are complements or substitutes, at the margin.

Variables affecting the spouse's market wage include:

● education

● experience

● demographic characteristics

Education and experience are standard variables included in a wage equation based on human capital theory. Other characteristics included in the wage equation are an indicator variable for race, an indication of whether English is the primary language, and an indication of whether the spouse is a U.S. citizen.

Military life variables affecting either the reservation wage, the market wage, or both include:

- Permanent Change of Station (PCS) move
- Average time at the location
- CONUS (continental U.S.) assignment
- Portion of military career spent overseas
- Number of PCS moves relative to years of Army service

An economic interpretation of a PCS move is that it causes a large, but temporary increase in the spouse's reservation wage, temporarily shifting up the supply curve and reducing weeks worked. It may also indirectly affect the market wage, to the extent that the likely withdrawal from the labor market is anticipated by potential employers. Time at a location can be expected to increase the market wage because the spouse becomes more familiar with the employment opportunities and wage distribution in the area and because, once employed, firm specific human capital accumulates over time. Labor market opportunities can be expected to be better for a CONUS assignment, while.the portion of time spent overseas and the relative number of PCS moves affect the spouse's labor market experience.

The probit equation predicting the probability of working is a reduced form equation that will include both variables affecting the reservation wage and variables affecting the spouses market wage. The wage equation will include only those variables that affect the spouse's market wage. The two-limit tobit supply

equation will, like the probability of working equation, include both the reservation wage variables and the market wage, predicted from the wage equation.

The explanatory variables, along with their sample statistics, are described below.

EXPERIENCE is an imputation of spouse work experience. This variable is defined as spouse age minus years of education minus five years (the assumed number of years before entering the first grade). The mean number of years of job experience is 10.7, with a standard deviation of 6.3. To account for the diminishing effect on work experience on labor participation, earnings, and supply, we include the squared value of experience. The mean for EXPERIENCE2 is 168. The standard deviation is 203.

EDUCATION is measured by three categorical variables. HIGH SCHOOL is defined as one if the individual's highest level of education is a high school degree, and zero otherwise. In addition, we assume a high school diploma for those who mark "don't know" for the highest level of education of the spouse. SOME UNIVERSITY is defined as one if the respondent has had some college-level education but no degree (zero otherwise). Similarly, COLLEGE is coded as one for a college degree or higher level of education, zero otherwise. The mean for HIGH SCHOOL is 0.55 (0.50 standard deviation). SOME UNIVERSITY has a mean of 0.23 (0.42 standard deviation); the mean of COLLEGE is 0.05 (0.23). Over eighty percent of the sample have at least a high school diploma. Non-high school graduates are included in the intercept.

ENGLISH is an indicator of the primary language spoken in the household. If the response is English the variable is coded as one; any other language is coded as zero. The mean response for the sample group is 0.87 with a standard deviation 0.34.

CITIZEN indicates United States citizenship of the spouse. If the spouse is a U.S. citizen, the variable is coded as one. The mean is 0.85 (standard deviation of 0.36).

Race is indicated by the variable WHITE. Because there is no questionnaire item on the Member Survey for the race of the spouse, this variable actually reflects member race and serves as a proxy for spouse race. White/Caucasian is coded as one; black/negro/Afro-

American, American Indian/Alaskan native, oriental/Asian/Chinese/Japanese, and other (including Hispanic) are all coded as zero. The resulting mean is 0.57 with a standard deviation of 0.49.

OVERSEAS is a ratio of time spent at foreign duty or OCONUS stations relative to total years of service . The mean is 0.30 (standard deviation 0.46). Approximately one-third of the members' total time in the military was spent at overseas locations.

PCS RATIO is the number of PCS moves of the spouse per year of service of the member. The mean of 0.40 (standard deviation 0.55) means that enlisted service members in the sample have changed stations every two to three years.

PCS 84 indicates whether or not the member made a PCS move during the year 1984. (Coded as one for yes, zero for no.) This variable is imputed using data on length of time at current duty station and month of survey completion. The mean is 0.31, with a standard deviation of 0.46. Nearly one-third of the sample changed locations in 1984. This is consistent with the standard three-year tour of duty.

AVERAGE TIME 84 is defined as the average number of months spent at the member's 1984 location in 1984 for those who did not make a PCS move in 1984. This measure must be imputed from the number of months at the time of the survey. We assume a 36 month tour. For example, if a member completes the DoD survey in February 1985, and reports that he has been at his present location for 30 months, then his value of AVERAGE84 is 22.5 (the summation of 16...28 divided by twelve). The mean value of AVERAGE84 is 14.9 months (standard deviation of 16.7).[6]

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[6] The "average time" variables and the PCS variable refer to the member, rather than the spouse. They are, of course, highly correlated with the spouse variables. However, we used the member variables for two reasons. First, the variables as they apply to the member relate directly to Army policies. Hence, we can quickly estimate the effect that increasing average CONUS tour lengths by 12 months will have on spouse wages. Second, the member variables serve as convenient proxy variables to reduce the possibility of biased estimates. For example, suppose that spouses who have abnormally good jobs choose not to accompany their member spouses. Using the spouse's "average time at a location" in the wage equation will result in a parameter estimate that is likely to be biased high.

BEFORE MOVE TIME is the number of months spent at a 1984 location before making a PCS move in 1984. Hence, BEFORE MOVE takes on a value between 1 and 12 when "PCS84" equals one. If the individual did not change stations in 1984, BEFORE MOVE is defined as zero. The overall mean is 1.7 with a standard deviation of 3.1. We hypothesize that moving later in the year affords spouses higher wages than early year moves. A spouse moving in November may report 10 months of wage rates at an accumulated level of growth and only two months at the new "entry" level wage rate, for example.

CONUS is a categorical variable that indicates the spouse's location. This variable is defined by member location and accompaniment status. If the member is at a Conus site, we assume the spouse is CONUS and code the variable as one. If the member is overseas, but unaccompanied, we again assume that the spouse is CONUS (code variable as one). If the member is accompanied at an overseas location, then the variable CONUS is coded as zero. The mean is 0.64 (standard deviation of 0.48).

Dependents (excluding the member and spouse) are measured by two variables. NUMDEPS indicates the absolute number of dependents -- the mean is 1.9 (standard deviation is 1.3). LESS6 is an indicator variable for children under the age of six. The code is one for a family with one or more children less than six years old and zero for families with no dependents in this age group. The mean for LESS6 is 0.50 with a standard deviation 0.5.

SEPARATE is a variable whose value is the number of months the service member spent away from his spouse or dependents as a result of military assignment in the past year. Respondents who answered "less than one month" are coded as 0.5. Others are assigned an integer between 0 and 12 depending upon months of separation. The mean is 3.5 months and the standard deviation of 3.5).

MEMBER WAGE is the taxable military income of the service member.[7] This information is not available from the DoD Survey, but instead is additional data provided by DMDC. Because of the large value of wages relative to other variables, we measure WAGES in

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[7] In retrospect, this variable should have been defined to include non-taxable allowances. In the reenlistment equation, the variable TOTALWAGES is defined to include basic pay, basic allowance for subsistence, basic allowance for quarters and the variable housing allowance.

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thousands. The mean for WAGES is 14.44 and the standard deviation is 3.9. Average military wages for the sample of enlisted personnel are $14,440.

OTHER EARNINGS measures the income of the family from sources other than wages. It is measured in thousands and has a mean of 0.9 (standard deviation of 4.6). The average value of outside income is about $900.

SPOUSE WAGE is the expected value of the spouse weekly wage, estimated from the wage equation, measured in logarithms. This estimate is derived for each spouse using coefficients from the wage equation and actual values of the explanatory variables for each of the variables in the wage equation. The result serves as input to the labor supply model. The mean for SPOUSE WAGE is 4.4, about $81.45 per week, with a standard deviation of 0.5.[8]

Summary statistics for the variables defined above are in Table 6.1.

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[8] This is the mean value for the sample, not just those who worked. The estimated weekly wage for the sample computed from the SPOUSE WAGE variable understates the true mean weekly wage slightly. The reason is that in the SPOUSE WAGE computation, we calculate the expected value of the log of wages, and convert it to dollars. In general $Ln[E(Wage)] > E[Ln(Wage)]$, where "E" is the expectations operator.

TABLE 6.1
VARIABLE MEANS AND STANDARD DEVIATIONS

VARIABLE	MEAN	STANDARD DEVIATION
EXPERIENCE	10.7 years	7.3
EXPERIENCE2	168 years	203.0
HIGH SCHOOL	0.550	0.50
SOME UNIVERSITY	0.230	0.42
COLLEGE	0.05	0.23
ENGLISH	0.87	0.34
CITIZEN	0.85	0.36
WHITE	0.57	0.49
NUMDEPS	1.9 children	1.3
LESS6	0.50	0.50
OVERSEAS	0.30 years/yos	0.46
PCSRATIO	0.40 moves/yos	0.55
PCS84	0.31	0.46
AVERAGE84	14.9 months	16.7
BEFORE MOVE	1.7 months	3.1
CONUS	0.64	0.48
SEPARATE	3.5 months	3.5
WAGES $000s	14.44	3.9
OTHEARN $000s	0.9	4.6
lnWAGEHAT	4.4	0.5

Note: Means are expressed as a proportion of the population unless other units are specified.

6.4 Descriptive Tabulations of Data

The data can be divided into many different cross-sections. For purposes of illustration, we examine the dependent variables for each of the three models across four separate groups defined by: education, PCS moves, location, and dependent status. All results are presented in Table 6.2.

Spouses with higher levels of education have higher levels of earnings, greater probability of work, and more weeks of labor supply. Over half of the sample has no more than a high school

diploma, while 23 percent have some university experience. Approximately 5 percent have a college degree and 17 percent have no high school degree. A college graduate earns nearly twice the wages of someone with no high school degree and works approximately 2.5 times more weeks per year than a non high school graduate.

Making a PCS move (about one third of the sample) seems to reduce earnings only slightly. Most importantly, spouses who do not change locations during the year are able to supply almost one additional month of labor.

Spouses located overseas (about 40 percent) earn more but work less than spouses living at CONUS sites. Spouses overseas may find high paying jobs or instead choose not to work at all. The decision to accompany the member abroad may also be contingent upon satisfactory employment, thereby accounting for the difference in wage opportunities.

The presence of children, especially those under the age of six, significantly reduce the labor supplied by the spouse. About half of the sample has a child less than six years old. These spouses on the average work nine weeks less during the year and earn over $40 less per week.

TABLE 6.2
EARNINGS AND WEEKS WORKED BY VARIOUS CHARACTERISTICS

	Weekly Earnings*	Prob Work	Weeks Worked
Education:			
no HS degree	$157.35	40.9%	10.7 weeks
HS graduate	$196.49	50.0	16.2
some university	$220.36	61.3	25.9
college or higher	$295.89	67.3	25.9
PCS Move in 1984:			
yes	$202.01	51.8	14.8
no	$209.80	52.8	18.5
Location:			
CONUS	$207.72	54.5	18.0
OCONUS	$217.24	49.3	15.9
Dependents Under Six			
yes	$185.85	43.6	12.7
no	$227.62	61.7	21.8

*Earnings are conditional upon working.

6.5 Labor Supply Model Estimates

The estimated parameters of the spouse labor supply model are reported in Table 6.3. Recall that the probit equation describing the probability of working is estimated as the first stage of the Heckman procedure. Because we observe wages only for those who work, estimates which do not account for sample selectivity may be biased. The inverse Mills ratio, related to the probability of working, is calculated from the probit equation. This variable is then included as "lambda" in the wage equation. Indeed, "lambda" is statistically significant, suggesting that the parameters from the wage equation would be biased if sample selectivity were ignored.

TABLE 6.3

SPOUSES OF ARMY ENLISTED MEN
WAGE AND LABOR SUPPLY EQUATIONS

	PROBABILITY OF WORKING PROBIT		WAGE EQUATION lnW		SUPPLY TOBIT-WEEKS	
	COEFFICIENT	T-RATIO	COEFFICIENT	T-RATIO	COEFFICIENT	T-RATIO
Constant	-.44	-4.67	2.84	8.36	-80.25	-12.44
Experience	.01	1.86	.05	3.20		
Experience squared	-.0005	-2.26	-.0009	-1.64		
High School	.04	1.05	.20	1.90		
Some College	.32	6.43	.34	2.65		
College	.44	5.73	.72	4.03		
Citizen	.29	6.18	.29	2.24		
English	.25	5.03	.12	0.90		
White	-.05	-1.75	.50	7.10		
Overseas Ratio	-.02	-0.65	.13	1.60	-2.93	-2.05
PCS Ratio	.01	0.45	.08	1.30	-.53	-0.44
PCS 84	-.04	-0.59	.15	0.99	-9.87	-6.71
CONUS	.06	2.01	-.04	-0.54	4.47	3.24
Average Time 84	.001	1.10	.01	4.82		
Before Move Time	.004	0.38	.04	2.05		
Number of Dependents	-.04	-3.38			-2.07	-3.90
Dependents < 6	-.42	-12.62			-16.39	-11.79
Separation (mos.)	.01	2.53			.24	1.38
Member Wage (000's)	.008	1.55			.59	3.24
Other Earnings (000's)	.005	1.63			.35	2.82
Lambda			-.70	-2.84		
Ln Spouse Wage Rate					18.60	12.83

Probability of Working Equation. Consider first the probit equation describing the probability that the spouse is employed. Note that the probit coefficients indicate the direction of the effect that a variable has on the probability of working but that the coefficients themselves are not partial derivatives.[9] For the most part, the variables have the expected signs. Dependents in general, but especially the presence of children under the age of six, greatly reduce the probability of working. Variables affecting the market wage, education and experience, have the expected sign and are significant.

Two variables are mildly puzzling. The variable indicating the number of months the spouses are separated because of Army duty, "separation", has a positive effect on spouse employment probability. If member and spouse time are substitutes at the margin in "household production" one would expect a negative relationship.

Two explanations suggest themselves. First, leisure or "home production" time of the member and spouse may be complementary, at the margin. If the member is not going to be around, the nonmember spouse may work rather than remain home alone. Second, "separation" may, in many cases, be a matter of choice. If the spouse has a satisfactory job, she may choose not to accompany the member in instances where there is choice. Under this interpretation, time spent separated is endogenous, and the estimated relationship may not be a causal one.

The second result that is somewhat troublesome is the positive sign on Member Wage and Other Earnings, though the

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[9] Let $P=F(XB)$ be the estimated probit equation describing the probability that the spouse is employed. Then

$$dP/dX_j = F'(XB)B_j = f(XB)B_j$$

where $F(..)$ is the cumulative standard normal distribution and $f(..)$ is the probability density function.

estimate is not different from zero at the usual levels of significance. A similar result also appears in the labor supply equation. Theory would suggest a negative sign if leisure is a normal good. However, one can rationalize a positive sign in cross-sectional data. If the household savings rate is a constant or increasing proportion of household income, families with relatively larger "other earnings" (i.e., interest and dividends) may be households with dual incomes in the past, and past behavior is probably correlated with current labor market behavior. Alternatively, members who tend to have above average earnings opportunities or tastes for work may tend to choose spouses who are similar. Such explanations, while possible, are unsatisfying.

Wage Equation. There are few major surprises in the wage equation. Experience and education variables have a positive and significant effect on the wage. Of some interest is the magnitude of the effects. A college graduate earns approximately 52% more per week than a high school graduate, and 38% more than a nonmember spouse with some college. Also, according to this equation, non-minority spouses earn about 50% more than minority spouses, on average.

The most important variable for policy is "average time at location" in 1984. For a one month increase in the average time at a location in a given year, the average weekly wage is approximately 1% higher. Interpreted literally, if all tour lengths were increased by 12 months, spouse weekly wages wage would, on average, be about 6% higher.

Tobit Supply Equation. The estimated supply equation also seems quite reasonable. It is upward sloping with respect to the expected wage, consistent with theory. Dependents, particularly the presence of dependents less than six years old, reduce the expected number of weeks worked by a relatively large amount. A PCS move also has a large negative effect on weeks worked.

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The coefficients alone in the supply equation tell only part of the story. The expected effect of a change in a variable is the sum of the effect that change has on the probability of working (supply a positive number of weeks rather than zero), the increase in the number of weeks worked for those who are working a positive amount but less than the maximum of 52, and the increase in the probability of working a full 52 weeks.

For example, the elasticity of supply of weeks worked with respect to the expected wage[10] conditional upon having worked a positive number of weeks, is about 1.2. However, the overall supply elasticity is about 0.5. The lower elasticity for the entire sample arises because 50% of the sample does not work. A small wage change for those already working will result in a small adjustment in weeks worked. For those not working, the wage change must be sufficiently large to induce them, typically, to make a large (nonmarginal) change in weeks worked -- from supplying no labor to the market to supplying some positive amount. Hence, the measured elasticity will generally be lower when the non-working group -- those at a corner solution -- are included. Similarly, a PCS move reduces the expected number of weeks worked, conditional upon working a positive number of weeks, by almost 10 weeks. However, on average a PCS move reduces the expected number of weeks worked by about 5 weeks.

6.6 Calculation of a Structural Measure of the Expected Loss In Spouse Labor Market Rents

In this section, we briefly describe the method used to estimate the spouse's expected loss in labor market rent if the family were to choose to remain in the Army and the assumptions underlying this method. There are three components of the loss:

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[10] More precisely, it is the expectation of the log of the wage.

the loss in labor market rent due to lower average wage rates, denoted as $Loss_R$; the loss do to a PCS move, denoted $Loss_{PCS}$; and the loss due to the probability of being stationed outside of the United States, denoted $Loss_C$. The total estimated loss in rent, denoted $Loss_T$, is the sum of the three components and is used as an explanatory variable in the reenlistment equation discussed in the next section.

$Loss_R$. To estimate this loss, we use both the wage equation and the labor supply equation discussed in section 6.5. First, we calculate the expected spouse wage assuming that the family will remain in the Army. To estimate this wage, the actual characteristics of the spouse are entered into the wage equation.

For the key variable, "average time at location in 1984", we enter the average for the sample in 1984. This average was approximately 14.5 months. The family reenlistment decision will encompass at least a four year horizon, if not longer. It would be obviously myopic to enter the precise value for the spouse in 1984. Army families will have different tour lengths, varying with Military Occupational Specialty, rank and other variables. In the absence of better information we assume that the average value of the time at location in 1984 represents the best estimate of the average annual value for each family.

The expected wage for each spouse conditional upon remaining in the Army, lnW^A_{fi}, is then entered into the supply equation to estimate expected weeks worked. Again, the spouse's own characteristics are entered into the equation.

The key variables, "PCS 84" and "CONUS", in the supply equation are analyzed somewhat differently than in the wage equation. These variables implicitly shift the labor supply function, affecting weeks of work. Initially, they enter the supply equation as zero and the sample average for PCS 84 and

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CONUS, respectively. Expected weeks of work, H^A_{fi}, are calculated from this equation.

The calculations for expected wage are then repeated, under the assumption that the family leaves military service and enters the civilian sector. A key issue is what to compare to Army life. One alternative would be to calculate the loss under the assumption that no moves are made once in the civilian sector. This would probably overstate the loss. In the wage equation, we set the variable "Average Time" equal to 30 months.[11] The wage variable, W^B_{fi}, is then entered into the labor supply equation, where H^B_{fi}, expected weeks of work, are computed.

From the points W^A_{fi}, W^B_{fi}, H^A_{fi}, and H^B_{fi}, the expected loss in labor market rent is computed for each spouse. The diagram below is representative of the area estimated.

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[11] One estimate is that approximately 20% of American families move each year. (See Solomon W. Polachek and Francis W. Horvath, "A Life Cycle Approach to Migration: An Analysis of the Perspicacious Peregrinator", in Ehrenberg, ed., _Research in Labor Economics_, v.1 1977.) From this, the average time between moves is approximately five years and the average time at a location would be 30 months. There are number of potential problems with this measure (e.g., the demographic differences in the military and civilian population) which we are forced to leave for future research to explore.
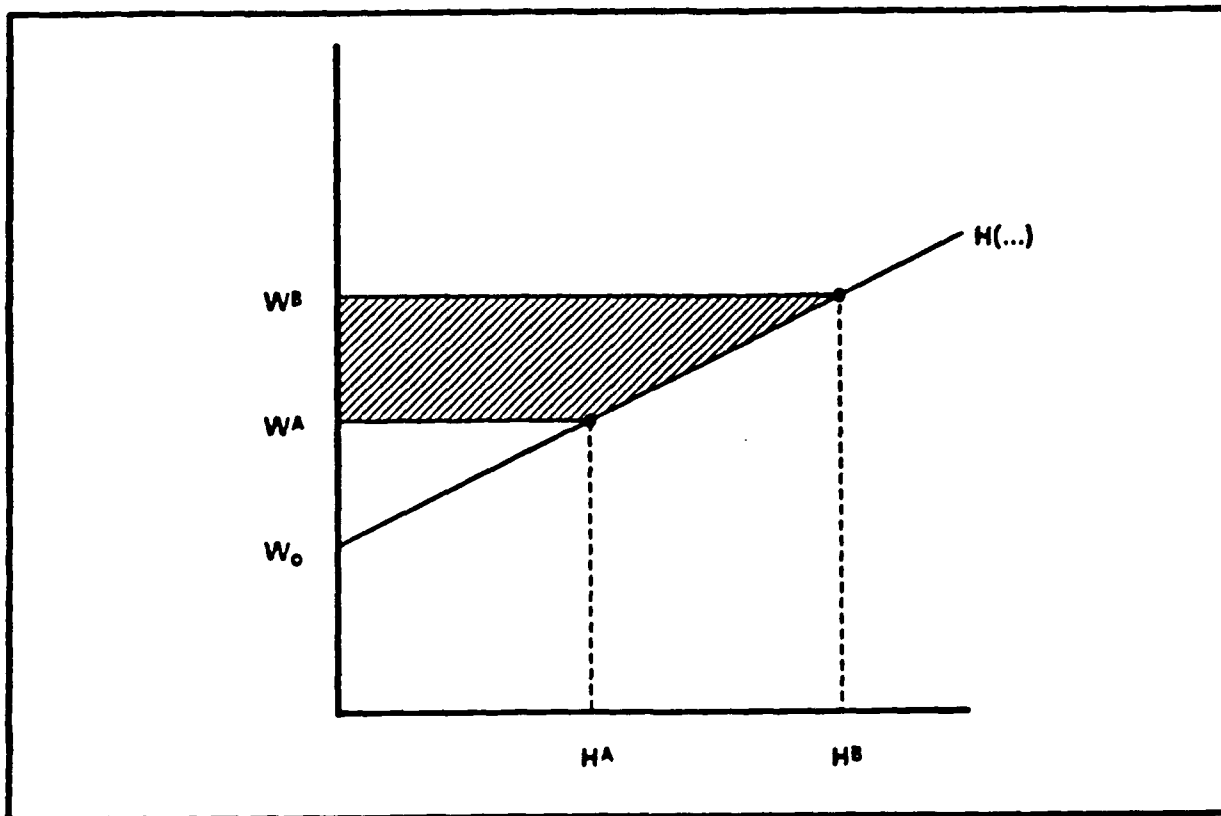
FIGURE 6.1   LOSS IN SPOUSE LABOR MARKET RENTS

Given these points, the expected loss in the spouse's expected annual labor market rent from remaining in the Army is calculated as:[12]

$$\text{Loss}_R = -(W^B_{fi} - W^A_{fi})H^A_{fi} + .5 (W^B_{fi} - W^A_{fi})(H^B_{fi} - H^A_{fi}) \qquad (6.1)$$

To this loss in "rent" we add two additional components: the annual expected direct loss due to a PCS move, and the expected loss from the being stationed outside of the United States.

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[12] Calculation of the expected weeks of work for each spouse is quite cumbersome, in that the probability that the spouse is at each limit as well as in between, is calculated as a function of all the variables in the supply equation.

Loss$_{PCS}$. First, we estimate the direct loss in earnings that arises through the reduction in expected weeks of work from a PCS move. This is calculated as:

$$\text{Loss}_{PCS} = - \,[1-F(-(gW^B_{fi}+BX)/S_e)]\; P(PCS)9.87\; W^B_{fi} \qquad (6.2)$$

The estimate of the loss in earnings due to a PCS move, should the family remain in the Army, is a product of the probability that the spouse would be working should they enter the civilian sector, $[1-F(-(gW^B_{fi}+BX)/S_e)]$, which is estimated from the tobit supply curve, and the average annual probability of making a PCS move in a particular year, $P(PCS)$, which is about .31 in our sample. This is then multiplied by the expected number of weeks of work lost conditional upon a PCS move, 9.87, and the spouse's expected wage in the civilian sector, W^B_{fi}.

Unlike the calculated loss in labor market rents, Loss$_R$, the Loss$_{PCS}$ measure assumes that the reduction in weeks worked due to a PCS move is not partially offset by the value of additional leisure or home production time. The reduction produces only a PCS move, not increased home production time for other purposes. The time lost from the market to make this move is valued by the Army family only as a necessary expense of remaining in the Army. Since the choice is to reenlist or leave, the net gain from leaving is the full market value of the time not lost to a PCS move.

This measure of the expected loss due to a PCS move varies with the spouse's characteristics both through the expected wage, W^B, and through the probability of working in the civilian labor market. The probability of making a PCS move, $P(PCS)$, was set equal to .31, the proportion of the sample making a PCS move in 1984.[13]

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[13] There are two potential problems with this measure. First,

$Loss_C$. The second component of this loss is the increase in work weeks resulting from the higher probability that the spouse will be permanently in the United States if the family does not reenlist. This calculation is equal to:

$$Loss_C = -[1 - F(-(gW^B_{fi} + BX)/S_e)] \ (1 - P(CONUS)) \ 4.47 \ W^B_{fi} \quad (6.3)$$

The estimate of $Loss_C$ is equal to the product of the probability of working, the expected increase in the proportion of time spent in the United States should the family leave the ARMY, the expected number of additional weeks of work if located in the United States rather than overseas, and the expected wage.

Note that in the calculation of $Loss_R$, we set the variable "CONUS" equal to its sample average of .64, indicating that 64% of the sample was located in the continental U.S. at the time of the survey. It is this probability that enters the evaluation of $Loss_R$. If the family chooses to leave and enter the civilian sector, we assume that they will permanently be in CONUS. Hence, the value of (1-P(CONUS)) is .36.[14]

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consistency suggests that the difference in the probability of moving in the Army relative to the civilian sector should be used, not solely a measure of move probability in the Army. Second, time spent moving has an opportunity cost even if that time would not be spent in the labor market. On the first issue, we simply do not have enough compelling information to make this adjustment. (In the wage equation, we are forced to set a non-zero civilian labor market value of "average time at a location". This value was both within the range of variation of our data, and has some basis in fact. Concerning the second issue, we experimented with including a term equal to the probability that the spouse does not work multiplied by the value of the reservation wage. This results in the counterintuitive result that those with the smallest probability of working suffer the largest loss from a move. It was dropped, but will be reexamined in subsequent work.

[14] Our calculation of $Loss_C$ assumes that the lost work weeks from being stationed overseas are not offset by the value of additional leisure or home production time. This might be the case, for example, if the lost weeks were spent searching for employment, and reflect greater difficulty in securing employment overseas.

The estimate of the value of the total expected loss in spouse labor market rents is the sum of the three components:[15]

$$\text{Loss}_T = \text{Loss}_R + \text{Loss}_{PCS} + \text{Loss}_C \qquad (6.4)$$

Our hypothesis is that our structural estimate of the value of the loss in spouse labor market rents has a negative effect on reenlistment probability. Moreover, this structural estimate will have a greater effect than a more ad hoc estimate of this loss that does not include the dollar equivalent value of leisure time.

6.7 Interpreting An Empirical Measure of the Loss in Spouse Rents

The average value of the expected annual loss in spouse labor market rent from remaining in the Army, across our entire sample, is $385. This may seem small, but it is important to understand the reasons for the magnitude of this estimate.

The estimate is the expected annual loss that a spouse, randomly selected from our sample, would be expected to incur in a year. The average value for the sample is small for several reasons. First, it reflects the probability of working. Those spouses who have a low probability of being in the labor market will have a relatively small loss. The loss conditional upon working is larger. In our sample, approximately 50% do not work.

On the other hand, it would not be unreasonable to argue that this measure overstates the loss, because of an offsetting increase in home production.

[15] Our method of treating the three components of the loss may understate the effect on expected weeks worked in the civilian sector. The reason for this underestimate is that we neglect the change in the probability of working that results from the civilian sector assumption regarding a PCS move and a CONUS location. Offsetting this is our stringent assumption that the family values the time spent not working due to a PCS move or a

Second, the loss due to a PCS move is weighted both by the nonmember spouse's probability of working and by the probability of making a PCS move in a given year. The former probability is about .5 for the sample, while the latter is .31.

To understand the implications, consider an example. Assume that a family in which the nonmember spouse is a high school graduate and is working in the market makes a PCS move. Because of that move, the spouse will work approximately 10 weeks less than she otherwise would. The family's earnings loss due to this specific move will be approximately $2,000. However, the expected annual loss is less. The probability of moving in a given year is .31, and the probability that the spouse will be in the labor market in the year of the move may only be .6. Hence, the expected annual loss in spouse labor market rents due to a PCS move for this family is about $360.[16] The difference is that between an estimate of the loss in a year conditional both upon the nonmember spouse being in the labor market and on the family moving that year, and an unconditional estimate of the loss.

The expected annual loss in spouse labor market rent will vary with the characteristics of the spouse. In general, highly educated spouses with few children, particularly few pre-school children, will suffer larger expected losses because they are more likely to be in the labor market, and more likely to command high wages. Though the mean expected loss in our sample is $385, the standard deviation is $218. The minimum value of the loss in our sample is $42 while the maximum annual loss is $1,750.

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non-CONUS location at zero.

[16] Note that this is only one of three components of the total expected loss in labor market rents.

6.8 Summary

In this section, we developed an empirical estimate of the expected loss in spouse labor market rents that is a direct application of the theory developed earlier in the paper. This expected loss is incurred from remaining in the Army rather than entering the civilian sector and is due to the costs military life imposes on spouse labor market opportunities. A structural estimate of this loss will permit analysts to evaluate policies affecting spouse employment and wages, such as PCS moves and overseas assignments, and to distinguish between the effect of these policies on spouse labor market opportunities and other effects they may have on the family. The structural estimates will also allow policy makers to better evaluate tradeoffs between the cost of programs that mitigate the adverse effects of military life on spouse labor market opportunities, and the cost of other ways of improving the well-being of the Army family.

As part of this analysis, we have estimated a probit equation of the probability of nonmember spouse employment, a spouse wage equation and a tobit spouse labor supply equation. These estimated equations are interesting in their own right, providing insights concerning spouse labor market behavior and the effects of military life on the spouse's wage and labor supply.

In the next section, the structural estimate of the value of the expected loss in spouse labor market rents is included in a quasi-reduced form reenlistment model. The hypothesis is that $Loss_T$ has a negative and statistically significant effect on the member's reenlistment probability, and that this measure performs better than more naive estimates that neglect the value of home production or leisure time.

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7.0 A QUASI-REDUCED FORM MODEL OF ARMY REENLISTMENT BEHAVIOR

In this section, we estimate a simple model of Army reenlistment behavior. The model is based upon the theoretical formulation developed in section 3.3, but is estimated as a "quasi-reduced form", one-period model.[1] We include a structural estimate for the loss the family expects to suffer due to the effect of military life on expected spouse earnings. The primary purpose of the reenlistment model is to determine how well this expected loss variable explains reenlistment behavior. Because of the simplicity of the reenlistment model, the results should be considered suggestive. The spouse expected loss variable, constructed in the previous section, is intended to capture the net financial incentive of the family to leave rather than reenlist due to the anticipated effect of reenlisting on expected spouse rents.[2]

The net incentive to reenlist due to differences in the member's financial opportunities is captured as a reduced form. We include the member's pay and allowances in dollar terms, but his civilian earnings opportunities are captured by the inclusion of variables indicating year of education and dummy variables indicating military occupation. Other variables are included, such as a year of service and a term of service dummy that capture the effects of censoring in the taste distribution as members progress through the system. Nevertheless, the model is kept

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[1] We call it a "one-period" model to distinguish it from a model that is estimated with panel data. In fact, it is a reduced form "ACOL" model where we have conditioned upon reenlistment term and years of service to account both for censoring in the "taste for service" distribution, and where we have assumed that our structural variable remains roughly constant over time.

[2] We measure this variable as the net "cost of reenlisting", so its expected sign is negative.

deliberately parsimonious -- it includes only those variables with an explicit theoretical rationale.[3]

Though the member's financial incentive to leave is captured by a reduced form, we will, to a limited extent, be able to analyze the tradeoff between increasing member's pay and reducing the labor market losses of the spouse as alternative ways of increasing retention. These tradeoffs should be of some interest to policy, particularly in the evaluation of programs to reduce the cost to the Army family of PCS moves. Further, we are able to analyze the effect of changing tour lengths on the labor market opportunities of the nonmember spouse and the effect that this will have on the family's decision to remain in the Army.

Our simple reenlistment equation allows us to test our structural measure of the value of the spouse's labor market loss which is the primary purpose of including it in this phase of research. We believe that this initial model provides suggestive results supporting further development of a structural model of household retention behavior.

7.1 The Model

The reenlistment model we estimate is closely related to the model described in equations (3.21) and (3.22) from the theory section. We have substituted $Loss_T$, defined in the previous section, for DR_i, the change in net financial rents, and include the member's Army pay and other reduced form variables affecting the member's or family's incentive to stay in XB. The criterion for reenlisting is, staff if:

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[3] This is not to say that it includes all variables that have a rationale for entering the model. The focus is on the financial variables. In future work, variables that capture additional nonpecuniary aspects of service should surely be added.

$$X_iB + \text{Loss}_T+ + e_i > 0 \qquad (7.1)$$

The retention probability is:

$$P_i = \int_{-(\text{Loss}_{Ti} + X_iB)}^{\infty} f(e) \, d e \qquad (7.2)$$

where $f(e)$ is the probability density function of e. If $f(e)$ is the normal density, for example, equation (3.22) can be estimated as a probit. On the other hand, if it is distributed as a Sech^2 the model can be estimated as a logit. The cumulative distributions are approximately the same. The probability that the ith individual reenlists is:

$$P_i = 1 - F(-X_iB) \qquad (7.3)$$

7.2 The Sample Population in the Reenlistment Equation

The sample population for which the reenlistment equation is estimated is quite homogeneous. First, the sample includes only Army enlisted male soldiers married to spouses who are not, themselves, in the military. Second, the sample is restricted to members who were in their first, second, or third term of service. Third, only those members who were within three years of their Expiration of Term of Service (ETS) were included. Finally, the dependent variable is self-assessed reenlistment probabilities.

The literature suggests that members who are married have a significantly higher reenlistment probability than members who are not married, other things equal. In this model, we attempt to explain the variation in reenlistment behavior of the male married population. The sample population is restricted to members who are in their third term of service, or less. Beyond the third

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term of service, reenlistment rates become very high and the population becomes even more homogeneous with respect to unobserved factors affecting reenlistment. In a given cross-section, those with between 14 and 20 years of service who intend to leave prio: to retirement typically do so for idiosyncratic reasons. Hence, in a simple model like this, there is little to be learned by including them in the analysis. Moreover, failing to account for this increasing homogeneity in a more sophisticated way than is offered in a cross-sectional data set may bias the parameter estimates.[4]

We restrict the analysis to those members who have less than 36 months remaining on their current reenlist. Those who are approaching a reenlistment point presumably will have given greater consideration to the decision than those who recently reenlisted. It may be argued that if a restriction of three years to ETS is good, two years may be better and one year to ETS best. If early reenlistment is a major phenomenon in the Army, limiting the analysis to one year or less to ETS may have resulted in a highly select sample -- those who chose not to reenlist early. This may mean that the expected value of the error term in this equation is negative, resulting in potentially biased parameter estimates.[5]

The dependent variable in the reenlistment equation is the self-assessed intention to reenlist, expressed as a

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[4] See Black, Matthew, and Paul F. Hogan, "A Dynamic Model of Navy Reenlistment Behavior", SRA, 1987, for one such way to adjust for potential bias due to unobserved heterogeneity. Panel data is necessary to use the techniques of that paper, but experiments within that framework indicated that the use of term and year of service dummy variables adequately accounted for censoring over the first three terms of service, resulting in unbiased parameter estimates, as long as there are no radical changes in incentives over the estimation or prediction period. We include both of these variables in the cross-sectional model.

[5] It would be interesting to test this hypothesis in future work.

probability.[6] This comes directly from the 1986 DoD Survey,
Question Number 30, in which the member is asked to provide his
probability of reenlisting. In particular, the member is offered
choices that include both a numerical estimate of the odds, (e.g.,
1 in 10) and a verbal characterization of those odds (e.g.,
"almost certainly not" for the 1 in 10 case). The member's
choices, and their characterization, are shown in the following
table:

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[6] Self-assessed reenlistment probabilities are not our first
choice as a dependent variable. Using self-assessed probabilities
clearly introduces bias when the reenlistment model includes other
attitudinal self-assessments. Variables like "how do you feel
about employment opportunities for your spouse" on a scale from 1
to 10 could be expected to be highly correlated with a self-
assessed reenlistment probability, even if actual behavior differs
significantly from intentions.

Our model includes no attitudinal variables. It is a model
based on (potentially) objectively measured explanatory variables.
It is meant to describe actual reenlistment behavior as the
outcome of rational choice. To the extent, then, that there is
noise between the self-assessed reenlistment probabilities and
actual behavior, it may be argued that the use of "intentions"
biases the analysis against our model because measurement error
increases the variance of the disturbance term and is, in a sense,
a more stringent test of the model.

TABLE 7.1

SELF-ASSESSED REENLISTMENT PROBABILITIES
QUESTION 30

Characterization	Odds
"Plan to retire"	. . . .
"Plan to leave the service"	. . . .
"no chance"	0 in 10
"very slight possibility"	1 in 10
"slight possibility"	2 in 10
"some possibility"	3 in 10
"fair possibility"	4 in 10
"fairly good possibility"	5 in 10
"good possibility"	6 in 10
"probable"	7 in 10
"very probable"	8 in 10
"almost sure"	9 in 10
"certain"	10 in 10

7.3 Variable Definitions and Sample Statistics

The definition of each of the variables used in the reenlistment equations are:

- Reenlistment Rate (Dependent Variable). When the member claims that his probability of reenlistment is "no chance" (0 in 10) we set that probability for analysis purposes at .01. When the member describes his probability of reenlisting a "certain" (10 in 10) we set the rate probability equal to .99. Similarly, when the member claims he plans to retire, the probability of retention is also set to .99, while if he asserts he is going to leave, it is set to .01. In all other instances, the probability is set equal to that probability implied by Table 7.1.[7] The mean reenlistment probability in our sample is about .615, and the standard deviation is .4.

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[7] In judging the efficacy of these choices, one should consider the interaction with the other filters determining the sample population. For example, most of those asserting that they are going to retire will be beyond the third term of service.

- Loss_T is the structural measure of the expected loss in the spouse's labor market rent should the household choose to reenlist. The mean value for all spouses, including those who did not work, is $385 and its standard deviation is $218. We expect a negative sign on this variable.

- Member's education is defined as both a continuous and a dichotomous variable. In the case where it is a continuous variable, it is the number of years of education achieved by the member. As indicator variables, education is defined as 1 if the member's highest level of education is high school and zero otherwise; one if the highest level is some college, zero otherwise; and one if the member is a college graduate, and zero otherwise. These variables are included to capture the effect of differences in civilian earnings opportunities that are due to differences in education. One expects that the higher levels of education have a positive effect on civilian earnings opportunities, other things being equal, and therefore a negative effect on reenlistment probability. The years of eduction in the sample is about 12.49, with a standard deviation of 1.1. The highest level of education was high school for about 68% of the members, some college for about 26%, while 3.1% were college graduates.

- Spouse's education is defined in a way analogous to the members. The interpretation is different, however. If the effects on spouse earnings are captured by the Loss_t variable, spouse education should not have an effect on the reenlistment decision except possibly through "tastes". If Loss_T does not adequately capture the effects on spouse earnings, a negative sign on spouse education is expected. The mean number of years of education for spouses is 12.35, with a standard deviation of of 1.6. For about 53% of the spouses, high school was the highest level of education, while 23% had some college and 4.9% were college graduates -- a larger proportion than their member spouses.

- Non-high school is a variable indicating that the member is not a high school graduate. It is included only when education is measured in years. Non-high school graduates have a high probability of being ineligible to reenlist. Hence, we expect a negative sign on this variable, when it is included. About 2.8% of the sample consists of members who have not been graduated from high school.

- Second term and third term are dummy variables indicating that the member is in his second or third term of service. They are included to capture the effects of "censoring" in the distribution of unobserved factors affecting retention that occurs as members move through reenlistment gates.[8] Since retirement benefits are not included in the the model, term of service may also capture the effect of an increasing present value of retirement. About 41% of the sample was in the second term of service, while 36% was in the third term. The relatively low proportion of first term members, 22%, arises from the sample criterion that the member must be married.

- Year of Service of the member also captures, to an extent, some combination of the natural tendency or reenlistment rates to rise with tenure due to censoring and the effect of the an increasing present value of retirement. The mean year of service in the sample is 7.23, with a standard deviation of 3.9.

- Members wages include annual basic pay, basic allowance for quarters, basic allowance for subsistence and variable housing allowance. It is a measure of the member's financial incentive to remain in military service. The mean of this variable is $12,571 and the standard deviation is $2,647.[9]

- Number of Dependents has been defined previously. In the reenlistment equation, it is intended to capture the value of certain in-kind benefits of military service, such as housing commissaries, medical benefits and so forth. The hypothesis is that these benefits will be valued more highly by the Army family, the greater the number in the family. The mean number of dependents for the sample, excluding the member and spouse, is 1.7 with standard deviation of 1.2.

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[8] The paper by Black, Hogan and Sylwester (1987) cited previously suggests that these dummies are reasonably effective in accounting for the bias resulting from unobserved heterogeneity.

[9] We were unable to determine whether the member was eligible for a reenlistment bonus from the survey data. This could easily be corrected by applying external bonus look-up tables, matched by the member's MOS to the survey data. Since most bonuses are paid at the first term and there is a relatively small proportion of first term members in the sample, this omission may not be a serious problem. Perhaps more troublesome, in retrospect, is that we did not impute a value to in-kind quarters for those who live on the post.

- Combat is a dummy variable that is equal to 1 for members in CMFs 11, 13 and 19. Hightech is also a dummy variable that is equal to 1 for members in CMFs 29, 33, 67, 74, 78, and 31. The former indicates the combat arms skills. It may capture the effects of onerous non-pecuniary conditions of service, in which case the expected sign is positive. The dummy variable for highly technical skills is a subjective assessment of skills that would be associated with members who have good civilian employment opportunities. The CMFs included are largely electronic and communication maintenance and operations CMFs, and automated data processing skills. About 19% of the members are in combat arms skills in this sample, while about 9% are in what we have defined as "hightech" skills.

- Marriage change is an indicator variable that is equal to 1 if the member has married since his last reenlistment or enlistment decision. It is an imputed variable, and is equal to 1 if four years minus the time remaining on his current contract is greater than the number of years he has been married. The hypothesis is that the addition of the spouse preferences in the reenlistment decision will have the greatest effect at the first decision point after matrimony. This variable is an indirect test of the "family" or household decision framework, and its expected sign is negative. Approximately 17% of the members were married since their last enlistment or reenlistment decision.

- Spouse earnings are included in some specifications in order to compare it to the structural measure of the spouse's loss. The naive hypothesis is that the effect of military life on spouse labor market opportunities is proportional to spouse earnings. Hence, a negative sign is expected. It has a mean of $3,228 and a standard deviation of $7,198.

The variables included in the model are summarized in the following table.

TABLE 7.2
SAMPLE STATISTICS

Variable	Mean	Standard Deviation
Reenlist Probability	0.615	0.4
Loss$_T$	$385.0	$218.0
Member's Education	12.49	1.1
Spouse's Education	12.35	1.6
Non-high school	0.028	0.16
Second Term	0.41	0.49
Third Term	0.36	0.48
Year of Service	7.23	3.9
Member's Wages	$12,571.0	$2,647.0
Spouse Earnings	$3,228.0	$7,198.0
Combat	0.19	0.40
Hightech	0.09	0.28
Marriage Change	0.18	0.38
Number Dependents	1.7	1.25

7.4 Empirical Results

If, from equation (7.1), we assume the e_i is distributed according the Sech^2 distribution, then the cumulative distribution is logistic. We can estimate the model as:

$$p_i = 1/(1+e^{-(X_i B)}) \qquad (7.4)$$

where p_i is the probability that the ith Army family reenlists, X_i is a vector of explanatory variables, and B is a vector of parameters to be estimated. Dividing (7.4) by $1-p_i$, and taking logarithms results in the logit model that is linear in the parameters:[10]

$$\ln(p_i/(1-p_i) = X_i B + u_i \qquad (7.5)$$

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[10] The error term in the linear model is not e_i. One interpretation of u_i is that it arises from differences between reenlistment intentions that members write down on the survey, and actual behavior.

This model is estimated by ordinary least squares. The estimated coefficients and the t-ratios are reported in Table 7.3. The relationship between the coefficients and the partial derivatives in a logit model is a simple one:

$$dp_i/dX_j = p_i(1-p_i)B_j \qquad (7.6)$$

The partial derivatives, evaluated at the mean reenlistment probability, are presented for the continuous variables.

TABLE 7.3
REENLISTMENT EQUATION ESTIMATES

Variable	Parameter	T-Ratio[11]	Derivative
Intercept	-2.740	-3.49	
No High School	-1.040	-2.77	
Member Ed	-0.080	-1.39	-0.019
Spouse Ed	0.058	1.55	0.014
Second Term	0.008	0.05	
Third Term	0.53	2.21	
Year of Service	0.094	3.33	0.022
Member Wage	0.00027	6.96	0.000064
Num Dependents	0.048	0.98	0.01
Marriage Change	-0.427	-2.71	
Combat	-0.17	-1.21	
Hightech	-0.43	-2.15	
$Loss_T$	-0.00073	-2.46	-0.00017

$R^2 = .136$
$AdjR^2 = .133$
observations=3418

[11] Because the variable, $Loss_T$, is estimated from a three stage procedure, the standard errors in the OLS regression are incorrect. Nevertheless, the t-ratios are typically similar to the t-ratios using the correct standard errors.

Both the member's wage and the spouse loss variable are statistically significant and of the right sign. An additional dollar of pay for the member will increase his reenlistment probability by only about 0.01% while a dollar's reduction in the loss of spouse's labor market rents will increase the probability of reenlistment by about 0.03%. The coefficient on total wages implies an elasticity[12] of about 1.3 at the mean, while the elasticity with respect to the spouse loss variable is about -0.12.

The elasticity with respect to the member's pay is quite consistent with other estimates found in the literature. There are no results in the literature with which to compare our estimate of the effect of the spouse's loss in market rent on reenlistment, but the magnitude of the effect does not seem unreasonable.

Not being a high school graduate lowers the probability of reenlisting by 24 percentage points, a percentage reduction from the mean of almost 40%. Other things being equal, one would anticipate that non-high school graduates would have a higher than average reenlistment probability, in a model of voluntary behavior, because they would have reduced civilian earnings opportunities. It is likely, however, that a high proportion of non-high school graduates are declared ineligible to reenlist by the Army. The large negative effect is likely to reflect this ineligibility.[13]

An additional year of member education reduces the probability of reenlistment by approximately 3% at the mean reenlistment probability. If this reflects solely the effect of education on

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[12] The elasticity in a logit model is simply:

$$(1-p_i)X_jB_j$$

as can be seen by inspection of (7.5).

[13] When this variable is dropped, the sign on member's education becomes positive, contrary to theory. This illustrate the importance of capturing the institutional details of the Army in an analysis of retention behavior.

civilian wage opportunities, and the military and civilian wages would have equal and opposite coefficients in a structural model, these results suggests that an additional year of education increases the member's potential civilian earnings by about $300. The coefficient, however, is not significantly different from zero at the usual levels of significance.

Additional years of education of the spouse have a positive effect on reenlistment probability. The interpretation of the coefficient should be the additional effect that spouse education has on reenlistment probability, holding $Loss_T$ constant, since spouse education enters the calculation of the structural loss variable. Although positive, the estimated coefficient is not statistically significant.

The two term of service indicators have the correct sign, though only the third term dummy is significant. This insignificance may be due to the relatively small portion of the sample in the first term coupled with the likely concentration of non-high school graduates and members who have recently married in the first term of service. Relative to members in the first term of service, those in the third term have a reenlistment probability that is approximately 13 percentage points higher, other things being equal.

The year of service variable is positive and significant. One might have anticipated that it would be insignificant, given the presence of the term of service substitute. A number of explanations are possible. First, it may capture the combination of the draw of the retirement system which increases with years of service, and the effects of censoring. Second, it may mean that holding term of service constant, reenlistment "intentions" increase as one approaches the decision point.[14]

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[14] A corollary of the argument made earlier on why reenlistment probabilities may decline, in a given cohort, as ETS approaches is

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Being in either a Combat or Hightech[15] Career Management Field has a negative effect on reenlistment probability, although the coefficient on Combat is not statistically significant at the usual levels. Those in "hightech" skills have reenlistment probabilities that are approximately 10 percentage points lower than the 70% of the sample members in excluded skills.

Number of dependents appears to have a small, positive, but insignificant effect on reenlistment probability. Again, the effect of dependents on spouse earnings loss is, presumably, captured in the $Loss_T$ variable. Hence, our hypothesis was that if it had a positive effect, it was a measure of the value of in-kind goods and services provided by the Army.

The "marriage change" variable is quite interesting. Recall that it is an indication of whether the member's marriage occurred subsequent to his last reenlistment decision. If it has, the member has approximately a 10 percentage point _lower_ probability of reenlisting. The conventional wisdom is that being married increases the probability of remaining in military service. This appears to be true on average in a cross-section of the force. However, the dynamics suggest that the effects of matrimony on reenlistment probability may be overstated. Marital status would appear to have a much greater effect on the future probability of reenlistment after the newly wed couple has decided to reenlist once.[16]

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that members who have a strong dislike for Army service may find ways to be discharged prior to ETS.

[15] As we have arbitrarily defined "hightech".

[16] The effect of the "marriage change" variable appears to be quite consistent with the economics of household reenlistment behavior that we have been developing. Upon becoming married, the the soldier has an additional set of preferences to consider. The value of his "home production" time is affected. There is a reevaluation of the non-pecuniary factors associated with military

The results of a specification which includes spouse earnings as an independent explanatory variable are displayed in Table 7.4. These results provide a weak test of an alternative specification that assumes that spouse labor market losses are simply proportional to earnings. Though the variable, spouse earnings, enters with the right sign, it is insignificant, indicating that it adds little to the reenlistment equation. Moreover, the coefficients on the other variables remain stable with the addition of this new variable.[17]

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service. Subsequent work will explore whether the initial effect of marital status on reenlistment probability is positive or negative by estimating a model using data that includes single members, married members, and members who have changed marital status since their last reenlistment decision.

[17] The higher adjusted R^2 in this regression is undoubtedly due to dropping observations. About 300 observations were dropped because they did not have data on spouse earnings. It may be the case that these observations had other specious answers on the survey.

TABLE 7.4
REENLISTMENT EQUATION ESTIMATES
SPOUSE EARNINGS INCLUDED

Variable	Parameter	T-Ratio
Intercept	-2.67	-3.33
No High School	-0.87	-2.28
Member Ed	-0.06	-1.05
Spouse Ed	0.04	1.08
Second Term	0.03	0.17
Third Term	0.65	2.64
Year of Service	0.10	3.40
Member Wage	0.00026	6.54
Num Dependents	0.014	0.27
Marriage Change	-0.424	-2.54
Combat	-0.15	-0.98
Hightech	-0.44	-2.21
$Loss_T$	-0.00068	-2.28
Spouse Earnings	-0.000004	-0.52

$R^2 = .144$
$AdjR^2 = .141$
observations=3096

When the variable, $Loss_T$, is dropped from the model, the coefficient on member wages falls slightly and the coefficient on member education rises (in absolute value), as can be seen in Table 7.5. This suggests the possibility that reenlistment models that exclude a measure of the cost military factors impose on a spouse's labor market opportunities may obtain biased estimates of the effects of military and civilian pay on retention, but these results suggest that the magnitude of the effect is likely to be small. Omission of spouse labor market effects probably does not result in biased estimates of the parameter on the member's pay.

The coefficient and significance level of the variable, number of dependents, rises in the absence of $Loss_T$. This suggests that the effect of dependents on retention is largely through the effect dependents have on the spouse's loss in labor market rents.

TABLE 7.5
REENLISTMENT EQUATION ESTIMATES
SPOUSE LOSS MEASURE EXCLUDED

Variable	Parameter	T-Ratio
Intercept	-2.35	-3.06
No High School	-1.06	-2.85
Member Ed	-0.09	-1.72
Spouse Ed	0.033	0.94
Second Term	0.05	0.30
Third Term	0.55	2.31
Year of Service	0.094	3.36
Member Wage	0.00025	6.60
Num Dependents	0.078	1.63
Marriage Change	-0.41	-2.62
Combat	-0.18	-1.27
Hightech	-0.44	-2.19

R^2=.135
AdjR^2=.131
observations=3418

Overall, the simple logit reenlistment rate model appears to be robust with respect to minor changes in specification. The structural variable, $Loss_T$, has a negative effect on reenlistment probabilities and is statistically significant.[18]

The household model of reenlistment behavior appears to offer interesting insights on the role of spouse labor market opportunities on the family's decision to remain in the Army. A next step is to develop the empirical reenlistment equation by including a structural measure of the member's Annualized Cost of Leaving (ACOL) that includes reenlistment bonuses, by including a richer mix of nonpecuniary variables, by testing for interaction effects, and by testing alternative assumptions used in calculating the expected loss in spouse labor market rents.

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[18] As noted previously, however, the t-ratios are only suggestive in this instance.

7.5 Limitations

The coefficients and significance levels of predicted variables, such as our measure of spouse losses, are often sensitive to other variables that are included in, or excluded from, the model. In the case of the spouse loss variable, the spouse wage rate and weeks of work are estimated as a function of spouse education, dependents, minority status, PCS moves, and other variables.

We conducted experiments to test the sensitivity of $Loss_T$ by selectively including variables in the reenlistment specification that are also important in the estimation of the spouse loss variable. The only variable that had a large effect on the significance of the loss variable was member minority status. It appears that the two variables are highly collinear. Subsequent research will explore this relationship.

The structural estimate of the spouse's loss suffers from a number of shortcomings in the current data. First, as noted previously, we are unable to distinguish between full time and part time spouse earnings. Two ways to proceed are to experiment with better filters using the current data, and to obtain better data. Second, there are no "demand-side" variables in the spouse wage or labor supply equations.[19] The reason for this is that the data set did not specify the location of the respondent.[20]

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[19] One could interpret the "CONUS" variable in the labor market equation as affecting labor demand.

[20] Nor did it have variables that indicate if the respondents are at the same location. If this information were provided, information on the survey may be used to derive demand side variables.

Subjective self-assessment of reenlistment probability, not actual behavior, is used as the dependent variable in the reenlistment rate equations. While the equations are, in fact, quite reasonable and not at odds with the rest of the literature, the estimates are always open to question on that basis.[21]

Finally, the data on spouse wages and earnings are limited to spouses who remained in the military. We have attempted to capture the major factors of military life that affect the wages of a military spouse. To the extent that variation in average time at a location, overseas versus domestic assignments and so forth have adequately captured the factors that affect a spouse's earnings relative to her earnings as a civilian, the expected civilian wage can be estimated. However, if military spouses can command significantly higher wages simply by not being labelled as military spouses by employers, for instance, the data used here will underestimate the loss in labor market rent.

7.6 Policy Implications: A Simulation

An advantage of structural estimates in a household model of reenlistment behavior is the policy insights they can offer. In reduced form models, policy implications are often unavailable or unclear. Consider the system of equations developed and estimated in this paper:

(1) Spouse wage equation describing the spouse wage as a function of spouse characteristics, other factors, and Army PCS policies;

(2) Spouse labor supply equation, predicting weeks worked as a function of spouse's expected wage, other factors, and PCS policies;

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[21] The latter two problems --location information for demand-side variables and "intentions" versus actual behavior -- will presumably be alleviated by the Defense Manpower Data Center's forthcoming data set matching respondents to personnel records.

(3) Parsimonious household reenlistment model as a function of the spouse's expected labor market loss, calculated from the wage and supply equation, and other characteristics of the Army member.

This structural system can be exercised to simulate the effects of changes in various policies on family welfare and retention. For example, consider a hypothetical example of extending all tour lengths by 12 months. This change would affect the system through a series of changes:

- Average cumulative time at a location in a year would increase. According to the spouse wage equation, spouse wages would rise on average by about 6 percent.

- Weeks worked per year would increase, through the wage effect in the labor supply equation, and the probability of working would increase.

- The frequency of PCS moves would decline, reducing the time lost from the labor market due to moving.

- Hence, the spouse's wages would increase, weeks worked would increase, and work lost due to PCS moves would decline, reducing the overall expected loss in labor market rents and increasing retention, other things being equal.[22]

A simple simulation was conducted using this system. Increasing average tour lengths by twelve months is predicted to reduce average expected spouse labor market losses by about $117, under our assumptions. This would imply an increase in the average

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[22] In the reenlistment equation, the effect of onerous overseas tours of duty was not explicitly modeled. Obviously, if those tours are extended, other things being equal, reenlistments may suffer. In future work, this can be tested by exploiting the variation in overseas relative to CONUS positions by MOS or CMF. Also, in the spouse wage equation, it would be interesting to interact the variable indicating a CONUS tour with the average cumulative time at a location variable, to determine whether the effect of tenure at a location differs significantly by CONUS and OCONUS tours.

reenlistment probability of about 3%.[23] To obtain the same effect on the reenlistment probability through the direct pay of the member would require about a 2.3% pay raise.

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[23] The increase was about 2 percentage points at the mean. The emphasis on "average" should have been included throughout this discussion. The average include the approximately 50% of spouses who did not work. Obviously, the effect on reenlistment probabilities will be significantly greater if we were to focus only on those spouses with a high probability of working.

8.0 SUMMARY AND CONCLUSIONS

This research represents the first attempt to develop a household or family model of retention behavior in a rigorous way. In this initial effort, the emphasis has been on deriving a household model from a sound theoretical framework and testing it using data from the 1985 DoD Member and Spouse Survey. In this concluding section, we briefly review the major accomplishments, both theoretical and empirical, of this effort, its limitations, and avenues for future research.

8.1 Tasks

This paper accomplished four major tasks:

(1) A theoretical model of the reenlistment decision from the household or family perspective is developed.

(2) The concept of labor market rent or consumer surplus is introduced as away of measuring the effects of military life on expected spouse earnings. This measure is preferred to differences in earnings between sectors, when time worked in each sector may differ, because it does not implicitly value non-work time at zero, as do differences in gross earnings.

(3) An empirical model of the nonmember spouse labor market is developed and estimated. This model consists of a spouse wage equation adjusted for potential self-selection bias and a tobit supply equation of weeks worked, with limits at both zero weeks and fifty-two weeks. The system includes variables that capture the effects of PCS moves and other variables on spouse wages and weeks worked. From the estimated system, the expected loss in spouse labor market rents is computed.

(4) An empirical reenlistment probability model is developed and estimated using self-assessed reenlistment probabilities. The simple model is used to test the effect of the variable representing the expected loss in spouse labor market rent on reenlistment probability.

8.2 Empirical Results

The major empirical findings include:

- The elasticity of the supply of spouse weeks worked with respect to the weekly wage is about .5 overall, and about 1.2 for those who are working. That is, a 10% increase in the spouse wage will increase the supply of weeks worked by about 5% overall, and by about 12% for those working.

- A month increase in the average cumulative time at a location increases the spouse wage by about 1%.

- A PCS moves in a given year reduces the number of weeks worked by about 4.5 weeks overall, and by about 9.9 weeks for those who are employed.

- Dependents, especially the presence of dependents less than six years of age, reduce the probability of working at all, and reduce the expected number of weeks worked in a year. The presence of dependents under age six reduces expected weeks worked in a year by about 16.4 weeks if the spouse worked at all, or by about 8 weeks overall.

- Spouses in CONUS had a higher probability of working than spouses outside of CONUS. For those spouses who worked, those in CONUS worked about 4.5 weeks more than those outside of CONUS.

- The expected loss in spouse labor market rent due to remaining in the Army has a negative effect on reenlistment probability. A 10% increase in this loss reduces members' reenlistment probabilities by about 1.1%.

- A 10% decline in the member's wage reduces the probability of reenlistment by about 13%.

- The literature suggests that being married tends to increase the member's reenlistment probability on average. However, if the member became married since his last reenlistment or enlistment decision, his probability of reenlisting is about 10 percentage points less (or 16% at the mean reenlistment probability) than other married members who have made at least one enlistment/reenlistment decision as a couple, other things equal.

8.3 Policy Implications

These results suggest that:

(1) Longer average tour lengths may reduce the adverse effects imposed by Army life on the nonmember spouse's labor market opportunities. In the simulation exercise conducted, increasing the average tour length by 12 months reduced the expected costs imposed on the nonmember spouse's labor market opportunities by about 35%, on average, increasing the average reenlistment probability by about 3%.

(2) Increasing the proportion of assignments in CONUS would also reduce the costs imposed upon the spouse.

(3) The Army is relatively more attractive to large families not simply because of the in-kind benefits offered by the Army, but because the loss in expected labor market rent will be smaller for these families.

(4) A dollar reduction in the loss in expected labor market rents will increase reenlistment probabilities by more than a dollar added to member pay. However, it is difficult to translate this into a policy prescription because it is difficult to estimate the full effects of reducing the expected loss in labor market rent by, for example, increasing tour length.

8.4 Limitations

This study suffers from several shortcomings, as does any study. The major problems have been noted previously, and only a brief summary will be provided here.

In the spouse labor supply analysis, part-time earnings were indistinguishable from full-time earnings. Limited experiments with several filters in an attempt to distinguish full and part time earnings were less than successful. Additional filters or another data set is the probable solution. Also, only broadly defined demand-side variables, such as CONUS, are included in the wage equations because of the inability to identify the precise location of the family in this data.

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The analysis data was the product of a survey with an approximately 60% response rate. While this rate is generally considered good, it opens the possibility of non-response bias. For example, if families with a high marginal value of time due to high wage offers are less likely to respond, the wage and labor market equations may be biased.

The dependent variable in the reenlistment equation is self-assessed reenlistment probabilities. While the variable appeared to work well, in that the estimated model was generally consistent with theory, the use of "intentions" rather than actual behavior is always subject to skepticism. Though the reenlistment equation was quite stable with respect to minor specification changes, experiments indicated that minority status and the expected loss in spouse labor market rent are collinear.

8.5 Avenues of Further Research

Perhaps the single most important shortcoming is that the study covered a very broad area -- from theoretical development, estimation and testing -- in a very short period. Consequently, there was not much room for experimentation along the way. While alternative specifications and variables were tested, the tests were not exhaustive and many interesting avenues of inquiry were left unexplored or partially explored.

Many areas for further research were noted in previous sections. Avenues for further research include:

- **Estimation Using Actual Reenlistment Data and Structural Measure of the Member's ACOL.** The household model was estimated for Army enlisted families using self-assessed reenlistment probabilities, a quasi-reduced form specification of the member's financial incentive to reenlist, and a relatively small number of variables indicating nonpecuniary differences. The model should be

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reestimated using actual behavior, a structural measure of the member's ACOL, a richer specification of the nonpecuniary factors affecting reenlistment behavior.

● **Estimation for Officer Families.** The loss in spouse labor market rents and the family retention model has been estimated only for enlisted families. A natural extension is to specify and estimate a model for officer families.

● **Spouse Earnings Data.** The spouse earnings data from the 1985 DoD Survey available at the time of our research suffers three shortcomings: (1) it does not include hours of work, making it difficult to discern differences in wage rates from differences in hours worked; (2) it did not permit identification of the spouse's specific location, making it difficult to control for local labor market conditions; and (3) it does not include data on the earnings of spouses from families who have left the Army, raising the question of whether we have captured all the effects of military life on spouse earnings opportunities. A recently released version of the Member and Spouse survey permits the researcher to identify families who serve on the same base. This permits adjustment for local conditions, using an average of the survey responses at a particular post that address local conditions. More interestingly, the 1986 DoD Survey of Reserve Members and Spouses would allow the researcher to use the spouses of reservists as a relevant comparison group for active duty military spouses. Reserve spouse earnings data, which are not affected by active duty military life, may provide excellent estimates of what the active duty member's spouse would earn, should the active duty family leave the Army. Finally, a number of assumptions were necessarily made in making our initial estimates of the loss in spouse labor market rent. Reestimation with an additional data set, the Reserve Survey, would allow us to reexamine those assumptions.

● **Nonresponse Bias.** In the 1985 DoD Member and Spouse Survey, only about 60% of Army enlisted personnel responded. A test for nonresponse bias in key questions, such as spouse earnings and self-assessed reenlistment probabilities, would indicate whether reliable population inferences can be made from this survey for those key questions. A method for testing for survey response self-selection bias is described in Goon and Hogan (1987).

● **Estimation Pooling Married and Single Member.** A truly general model of household retention behavior should be able to explain both the reenlistment behavior of married and single members. The household model developed in this paper can be extended to do both. The key methodological issue would be the endogeneity of marital status, and the sorting behavior that represents, as suggested by our results using the indicator variable for newly married

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couples. The model would be estimated using data that
pooled observations for single and married members.

Overall, the paper accomplished its purpose. An underlying
theory of the a household reenlistment model is developed, along
with a measure of the loss in spouse labor market rents. A system
of labor market equations is estimated, and a simple reenlistment
probability model was used to provide a test of the theory.
Finally, the research has raised intriguing questions that could
not be answered within the scope of the initial project.

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APPENDIX A

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Sociological Retention Literature

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    This report is a final draft of recommendations generated from two previous meetings on the impact of the family on retention. Representatives from MPX, MPP, MPC, LEE, SGH, and HC recognize the influence of family and spouse on career decisions and recommend steps to improve the quality of Air Force life. Eighteen initiatives or recommendations are proposed that address concerns of personnel who have left the Air Force.

Archer, Robert P., <u>An Investigation of Factors Related to Reenlistment Decisions Among Married Naval Personnel</u>. Proposal to the Naval Manpower Research and Development Program, February 3, 1986.

    This proposal describes a study that would model the criteria used by Naval personnel and their families to reenlist or detach. The analysis would include variables that measure the impact of Navy Family Services' programs on the intent to reenlist.

Army, Department of the, "The Army Family." Chief of Staff White Paper, 1983.

    This paper establishes the formation of an Army Family Action Plan. It also provides a history of the Army's commitment to the Family, traces the development of Army Community Services, and presents important statistics on marital and dependent status in the Army.

Army, Department of the, "The Army Family Action Plan III." Pamphlet 608-41, May 20, 1986.

    This pamphlet describes the Army Family Action Plan III, the management vehicle developed to implement family programs and policies. It is a revision of the original plan published 8 January 1984 and modified 20 May 1985. The general thrust of the plan is to identify family member concerns, determine actions required to resolve the problems, and assign agencies at the Department of the Army to implement actions to resolve the issues.

Army, Department of the, U.S. Army Community and Family Support Center. 1986.

This information booklet presents a brief history of the Army's involvement with families, including a description of the U.S. Army Community and Family Support Center (USACFSC) organization, and an overview of USACFSC current efforts to help commanders improve life for Army families.

Bowen, Gary L., Spouse Support and the Retention Intentions of Air Force Members: A Basis for Program Development. The University of North Carolina, 1985.

This study draws on a sample of 700 Air Force couples to examine the impacts of spouse support on the retention intentions of enlisted men, officer men, and enlisted women. Using path analysis and restricting the sample to members with less than ten years of service, spouse support has a significant and positive effect on the retention intentions of all three groups.

Dansby, Mickey R., and Janice M. Hightower, "Family and Work in the Air Force." Proceedings, Psychology in the Department of Defense, Ninth Symposium, 1984.

Models using multiple regression techniques are constructed to predict job related satisfaction (JRS), perceived work group effectiveness (PWGE), and career intention (CI) to remain in the Air Force. Data sources are the Organizational Assessment Package (OAP) and the Air Force Spouse Survey (AFSS). Family and spousal attitudes contribute strongly to the model. Suggestions to improve family life include increasing spousal job identification, giving more time off to be with family, providing compatible member/spouse work schedules, minimizing family moves and TDY separation, and improving economic security, recreation, and dental services.

Farkas, Arthur J., and Kathleen P. Durning, Characteristics and Needs of Navy Families: Policy Implications. Navy Personnel Research and Development Center, Special Report 83-1, October 1982.

Navy enlisted and officer men and women with dependents (1979 population) were surveyed on aspects of the service member, family, and job. The initial sample was 2126; there was a 40% response rate and a final sample size of 701. Models for reenlistment intention and stress are developed using statistical techniques. The best predictors of reenlistment intention in the model are general satisfaction with Navy life, family pressure to leave the Navy, and sex (lower for females). The best predictor of family pressure was perceived Navy interference with family life. Navy interference was related to total deployment time,

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hours per week with spouse, hours in the Navy work week, and amount of social support received from supervisors.

Grace, Gloria Lauer, and Mary B. Steiner, Navy Wives' Attitudes as a Factor Influencing Retention of Navy Enlisted Personnel. Office of Naval Research, Navy Manpower R&D Program.

Navy wives living in the San Diego, Norfolk, and Pearl Harbor areas were surveyed in 1973 and 1976. Data was analyzed using two-way ANOVA and Chi-square techniques. Findings indicate that wives tend to have favorable attitudes toward the Navy, but that non-career wives tend to be less favorable than others. Wives' satisfaction tends to vary directly with willingness for husbands to reenlist.

Hickman, Robert A., and Edna J. Hunter, Military Retention and Retirement: Reciprocal Family/Organizational Effects. USAF Office of Scientific Research, and Office of Naval Research (Organizational Effectiveness Research Program), June 1981.

The authors review literature that establish a link between the retention decision and spousal attitudes towards the military and the family members' commitment to the organization. Also addressed are the retention decisions of active duty women, the focus of military planners on family issues subsequent to the advent of the all-volunteer force, and the literature on the family ramifications of military retirement.

Hunter, Edna J., "Familypower: An Issue in Military Manpower Management." Paper presented at the joint Interuniversity Seminar - Air University Symposium on "Changing Military Manpower Realities: Strategic and Organizational Implications in the 1980s," Maxwell AFB, June 1979.

The military family has become a powerful force in military planning. The author discusses the influence of the family on the service member's job satisfaction and retention. She concludes that greater military awareness of family needs is necessary to alleviate the stress on the military family.

Kringer, Major Leo E., Spouse Attitudes and their Effects on Retention: An Analysis of the USAF Spouse Survey. Air Command and Staff College, Maxwell AFB, 1986.

The author uses the Air Force Spouse Survey (AFSS) to examine the relationship between demographic and attitudinal variables of the spouses and their desire for members to remain in the service. Using multiple regression and one-way analyses of variance (ANOVAs), the study concludes that 1) spouses report more member job stress compared to civilian counterparts and low pay relative

to the work required, 2) job benefits, services, and patriotism
are important influences on the wives' desire for husbands to
remain in the service, 3) the Child Care Center receives negative
ratings, 4) wives who support their husband's military careers
want more information about the Air Force, and 5) TDY attitudes
are important in the retention decision for those affected.

Lewis, Philip M., Family Factors and the Career Intent of Air
Force Enlisted Personnel. USAF Office of Scientific Research,
Bolling Air Force Base, 1985.

     The author assesses the Air Force Family Survey (AFFS), the
state of Air Force families, and the impact of spouse attitudes
and family characteristics on the job attitudes and career intent
of enlisted personnel. Results show that spouses view military
life as more stressful than civilian life, but remain supportive
of the Air Force. Sources of stress include disruptions caused by
work schedules, TDYs, military exercises, and recalls. Reduced
employment opportunities and reduction in family income upon
transfer to a new location also have a negative family impact.

Orthner, Dennis K., and Joe F. Pittman, Jr., Linkages Between
Family Support Variables and Military Career Commitments.
University of Georgia, 1984.

     This study 1) tests an empirical model that describes the
linkages between family/community variables in the Air Force job
community and spouse support for Air Force careers and 2)
identifies preliminary impacts of Family Support Centers on the
model. The data was collected from probability samples of Air
Force members and spouses and analyzed by means of path analysis.
Results show that family support variables contribute to over one-
third of members' job commitments and one-fourth of Air Force
spouse support.

Szoc, Ronald, Family Factors Critical to the Retention of Naval
Personnel. Naval Personnel Research and Development Center,
August 1982.

     A 338-item questionnaire was mailed to 5028 Naval officers
and enlisted personnel to model the relationship between family
factors and retention. The useable response rate was 33.1%.
Results show that four variables directly determine the retention
decision: spouse opinion, satisfaction with Naval family life, job
satisfaction, and years of Naval service. Four other variables
have an indirect effect on retention: degree of perceived social
support, satisfaction with Navy services, marital satisfaction,
and feelings concerning family separation from deployments.

Black, Matthew, John T. Warner, and James E. Arnold, Retention of DoD Civilians. Systems Research and Applications (SRA) Corporation, April 1985.

This study builds on the Annualized Cost of Leaving (ACOL) Model developed by Nelson, Warner, and Enns. This second generation ACOL-2 model corrects for the problem of self-selection bias in the original ACOL model. The authors review the relevant literature, specify a theoretical ACOL-2 model of retention for Federal civilian workers, and use longitudinal data files for three groups of workers to empirically estimate the model. Plans for the development of an automated DoD civilian retention policy analysis model are also addressed.

Chipman, Mark, Comparative Analysis of Enlistment Retirement Behavioral Models. NPRDC-TN-80-1, November 1979.

Chipman estimates the ACOL model. His method and results are consistent with Warner (1979).

Chow, Winston K., and J. Michael Polich, Models of the First-Term Reenlistment Decision. Rand Corporation, R-2468-MRAL, September 1980.

This report assesses the influence of regular military compensation, bonuses, in-kind allowances, negative aspects of military service environment, civilian employment opportunities, the draft, and individual attitudes toward military service on the reenlistment decision. The data source is a representative sample of 4000 first-term Army, Navy, and Air Force enlisted personnel from the 1976 DoD survey. All personnel were within one year of the reenlistment point -- subsequent record inspection showed a close correlation between reenlistment intention and actual reenlistment. The model is estimated using a multivariate logit specification.

Daula, Thomas, and Robert H. Baldwin, "Reenlistment Decision Models: Their Roles and Limitations in Policymaking." Paper presented at the Army Manpower Economics Conference, Williamsburg, VA, December 5, 1984.

This paper discusses the uses of econometric reenlistment decision models in the policymaking process. The authors conclude that, given current techniques and data, econometric reenlistment models can do no more than provide qualitative insight. The study reviews statistical problems (including errors in variables, model

specification, selection bias, and alternative civilian earning scenarios), shows how these problems affect parameter estimates, and offers suggestions for future research (especially the need for better data).

Enns, John H., _Effect of the Variable Reenlistment Bonus on Reenlistment Rates: Empirical Results for FY 1971_. Rand Corporation, R-1502-ARPA, June 1975.

    Enns estimates the effects of variable reenlistment bonuses and selective reenlistment bonuses on retention for first-term personnel across all Services.

Enns, John H., Gary Nelson, and John T. Warner, "The Economics of Retention and Retirement: The Case of the U.S. Military." _Policy Sciences_, 1984.

    The authors estimate the ACOL model with methods and results similar to Warner (1979).

Fernandez, Richard L., Glenn Gotz, and John McCall, _The Dynamic Retention Model_. Rand Corporation, N-2141-MIL, September 1984.

    This study describes the Dynamic Retention Model (DRM), a model developed at the Rand Corporation to predict officer voluntary retention rates. One of the primary characteristics of DRM is that it accounts for unobserved individual-specific factors affecting retention. Theoretical assumptions of the DRM, its applications to military policies, and actual empirical estimates of the model are included.

Goldberg, Matthew, and John T. Warner, _Determinants of Navy Reenlistment and Extension Rates_. Center for Naval Analyses, CRC-476, December 1982.

    Goldberg and Warner analyze the determinants of reenlistments and extension rates among first-term and second-term Naval enlisted personnel with specific attention on the effects of regular military compensation and reenlistment bonuses. Equations are specified and estimated in nine occupational categories. Extend is a third option, in addition to reenlist or leave the service. Results indicate substantial variability among pay elasticities across occupational groups -- the total probability of staying with respect to Regular Military Compensation ranges between 1.12 and 2.72 for first termers and 0.94 and 3.78 for second termers.

Grubert, Harry, and Rodney Weiher, "Navy Reenlistments: The Role of Pay and Draft Pressure." In Studies Prepared for the President's Commission on the All-Volunteer Force, 1970.

   This study estimates reenlistment equations for first-term Navy personnel using a functional form that is linear in the natural logarithm.

Hosek, James, and Christine Peterson, Reenlistment Bonuses and Retention Behavior, Rand Corporation, R-3199-MIL, 1985.

   The authors estimate a trichotomous logit model for first term (3.8 pay elasticity) and second term (1.7) retention decisions using grouped service data where the choices are reenlist, extend, or leave. The pay variable is an index of military relative to civilian pay, and the specification is unrelated to the random utility model of choice behavior implicitly used in the ACOL model of Warner and Goldberg.

Lakhani, Hyder, and Curtis Gilroy, "Army Reenlistment and Extension Decisions by Occupation." Paper prepared for the U.S. Army Manpower Economics Conference, Williamsburg, VA, December 5-7, 1984.

   Lakhani and Gilroy analyze the impact of pay and bonus on reenlistment and extension probabilities in 15 U.S. Army military occupations. The authors specify a trichotomous model of first term retention where compensation varies by career management field (CMF). Pay elasticities with respect to reenlistments range from 1-15 across CMF. The Army needs to utilize pecuniary compensation tools to increase reenlistment probabilities among highly skilled personnel with high civilian demand and low pay elasticities.

Nelson, Gary, "Economic Analysis of First Term Reenlistments in the Army." In Studies Prepared for the President's Commission on an All-Volunteer Force, 1970.

   Nelson analyzes first-term Army reenlistments using a log-linear specification.

Rodney et al., The Impact of Selective Reenlistment Bonuses Upon First and Second Term Retention. RGI, 1980.

   This study differs from the basic ACOL framework in its specification of two wage variables in the same equation. Results show a pay elasticity of 2.3 in models of first and second term Navy reenlistment decisions.

Smith, D. Alton, and Marjorie E. Goon, Air Force Family Support Centers: Effects on Personnel Retention and Readiness. Systems Research and Applications Corporation, February 1987.

Using the 1985 DoD Survey of Officers and Enlisted Personnel, augmented with data from personnel files, multivariate models are estimated to measure the effect of Family Support Centers (FSCs) on retention and readiness. There is strong statistical evidence of increased knowledge and use of family services and programs on FSC bases. There is slight evidence for a positive FSC effect on officer retention, but no evidence for an enlisted effect. There is slight evidence that both officers and enlisted personnel at FSC bases report fewer obstacles in responding to duty requirements, a component of personnel readiness.

Smith, D. Alton, and Marjorie E. Goon, "Spouse Employment and the Retention of Air Force Officers: Some Preliminary Results." Paper presented at the Annual Meeting of the Eastern Economic Association, March 1987.

This study develops a theoretical model of the relationship between retention rates and spouse employment, and estimates reduced form retention models for Air Force officers using data from the 1985 DoD Survey. Results show that officers with wives in the labor force (or who would be if their husbands left the service) have lower retention rates. Empirical estimates reveal a small, negative relationship between actual retention and spouse labor force participation. The impact of spouse employment depends on the difference between spouse earnings under stay/leave scenarios. Spouse employment effects are more negative among young officers.

Warner, John T., Alternative Military Retirement Systems: The Effects on Enlisted Retention. Center for Naval Analyses, CRC-376, 1979.

This is the first logit estimation of the ACOL model. Using grouped cross-sectional Navy data from YOS 4 through 16, the author finds pay elasticities between 2 and 3 at the first-term point.

Warner, John T., Determinants of Reenlistment and Extension Rates in the Unites States Marine Corps. Center for Naval Analyses, CNA-82-1733, 1982.

Warner estimates a sequential logit version of the ACOL model for both first and second term reenlistment decisions in the Marine Corps using grouped data from FY 1977-78. Pay elasticity results range from 1-2 in the first term and 1-3 in the second term.

Warner, John T., _Military Compensation and Retention: An Analysis of Alternative Models and Simulation of a New Model_. Center for Naval Analyses, RC-436, 1981.

The author reviews several retention models and develops a new model, the Stochastic Cost of Leaving (SCOL) model. SCOL derives a stochastic time horizon as the rational reaction to uncertainty.

Wilburn, Robert, "The Impact of Income, the Draft, and Other Factors on retention of Air Force Enlisted Men." In _Studies Prepared for the President's Commission on an All-Volunteer Force_, 1970.

Wilburn estimates the effects of draft and pay on the retention of first-term Air Force enlisted personnel under a logit specification.

Zulli, David, _Zone C Recommitment Elasticity Estimates_. The Assessment Group, 1982.

Zulli estimates a sequential logit model for enlisted Navy personnel making their third reenlistment decision and finds a pay elasticity of 0.64.

Economic Household Production Literature

Ashenfelter, Orley, and James Heckman, "The Estimation of Income and Substitution Effects in a Model of Family Labor Supply." _Econometrica_, Volume 42, Number 1, January 1974, pp. 73-85.

This paper applies the classical theory of consumer behavior to the household demand for leisure to formulate theoretical restrictions on the labor supply functions of the husband and wife in a model of family labor supply. Results give support to classical restrictions and improve parameter estimates using cross-sectional data from the 1960 U.S. Census of Population. Further data analysis may allow integration of the consumer's demand for nonmarket time with his demand for goods and services to produce estimates of complete consumer demand functions.

Barnett, William A., "Pollak and Wachter on the Household Production Function Approach." _Journal Of Political Economy_, Volume 85, Number 5, October 1977, pp. 1073-1082.

The author disputes the conclusion of Pollak and Wachter in "The Relevance of the Household Production for the Allocation of Time." The present study develops a structural form in which all functions have known neoclassical properties, derives household structure where tastes are Bergson and technology is Hybrid Diewert, and argues that joint production assists in identification without introducing neoclassical theoretical complications. An alternative shadow price concept is also presented.

Barron, John M., and Stephen McCafferty, "Job Search, Labor Supply, and the Quit Decision: Theory and Evidence." _The American Economic Review_, Volume 67, Number 4, September 1977, pp. 683-712.

This theory of quit behavior encompasses three options facing the employed individual: employed job search, unemployed job search, or no job search. Contrary to previous research, the second choice may be consistent with utility maximizing behavior. Results of the model indicate that quits entering unemployment are procyclical with demand for labor -- a fall in the vacancy rate increases the proportion of quits entering unemployment.

Becker, Gary S., "Division of Labor in Households and Families."
Chapter 2 in A Treatise on the Family (Becker), Harvard University
Press, 1981, pp. 14-37.

   The greatest division of labor within households occurs
between married women, who traditionally devote time to
childbearing and domestic activities, and married men, who
primarily engage in market activities. Divisions of labor in the
family are determined by both biological differences and different
experiences and investments in human capital. Becker gives
several theorems which show that comparative advantages produce
efficient division of labor when no more than one household member
engages in both market and household production.

Becker, Gary S., "Human Capital, Effort, and the Sexual Division
of Labor." Journal of Labor Economics, Volume 3, Number 1, Part
2, January 1985, pp. 33-58.

   Increasing returns from specialized human capital creates a
division of labor in the allocation of time and investments in
human capital between married men and women. Because of energy
spent on child care and housework, married women spend less effort
on each hour of work than married men working the same number of
hours. As a result, married women have lower hourly earnings than
married men and they attempt to economize on market work effort by
seeking less demanding jobs. The responsibility of married women
for childcare and housework helps to explain earnings and
occupational differences between men and women.

Becker, Gary S., "A Theory of the Allocation of Time." The
Economic Journal, Volume 75, September 1965.

   Assuming that households are consumers as well as producers
of commodities, the author analyzes the effect of changes in
earnings, other income, and goods prices on the allocation of
time. An increase in earnings, compensated by a decrease in other
income to keep full income constant, results in a decline in the
amount of time spent on consumption activities, because time
becomes more expensive. The decisions to reallocate time, goods,
and commodities are made simultaneously.

Blau, David M., "Family Earnings and Wage Inequality Early in the
Life Cycle." The Review of Economics and Statistics, Volume 56,
Number 2, May 1984, pp. 200-207.

   The author uses labor supply behavior and On-The-Job (OTJ)
accumulation of human capital to explain that wives contribute to
equalizing the distribution of family earnings and wage rates.
The magnitude of the wage rate effect declines later in the life
cycle -- after childbearing years, women tend to sacrifice initial
wages for rapid wage growth provided by substantial amounts of

OTJ. In contrast to wage rates, empirical results from the
National Longitudinal Survey of Young Women do not show a decline
in the magnitude of the earnings effect over time.

Cain, Glen G., "Welfare Economics of Policies toward Women."
Journal of Labor Economics, Volume 3, Number 1, Part 2, January
1985, pp. 375-396.

Government policies that promote market work by women are
analyzed in terms of efficiency and equity. Efficiency involves
market failure and labor market discrimination. Equity involves
the economic well-being of women relative to men. The case for
interventionalist policy is weak on efficiency but strong on
equity grounds. Alternative measures of economic discrimination
are proposed to replace conventional measures of labor market
discrimination against women. To measure this new concept of
discrimination, the author shows that women are poorer than men
during their adult lives.

Frank, Robert H., "Family Location Constraints and the Geographic
Distribution of Female Professionals." Journal of Political
Economy, Volume 86, Number 1, February 1978, pp. 117-130.

A smaller percentage of professional men live in two-career
families than professional women. The restriction that couples
take jobs in the same geographic location thus affects women more
than men. The author constructs a model of the placement process
that predicts the geographic distribution of female professionals
in the absence of employer discrimination. Results show that the
distribution is skewed towards large urban markets; the conclusion
is that the proportional guidelines of the Affirmative Action
program discriminate against employers in small labor markets.

Graham, John W., and Carole A. Green, "Estimating the Parameters
of a Household Production Function with Joint Products." The
Review of Economics and Statistics, Volume 56, Number 2, May 1984,
pp. 277-282.

The authors estimate the parameters of a Cobb-Douglas
production function whose output is household product and whose
input consists of family time and market goods. Results show
substantial joint production -- the degree to which time devoted
to home production simultaneously serves as leisure (greater for
wives than for husbands). Another conclusion is that both husband
and wife possess human capital skills more productive in market
work than in home work.

Grossbard-Shectman, Amyra, "A Theory of Allocation of Time in Markets for Labour and Marriage." The Economic Journal, Volume 94, Number 376, December 1984, pp. 863-882.

This study presents a theory of interrelated labour and marriage markets. Demand and supply schedules for labour and household labour are derived based on a theory of allocation of time and under the assumption that individuals can enter and leave marriage contracts. Hypotheses include that labour force participation of married women varies with the sex ratio of those eligible for marriage, that income changes influence wives' labour supply more than husband's, that group differences in the division of household labour influence the elasticity of female labour supply, and that a positive correlation between achievement in markets for labour and household labour provide an explanation for backward bending labour supply.

Hollister, Robinson G., "The Labor-Supply Response of the Family." The Journal of Human Resources, Volume 9, Number 2, Spring 1974, pp. 223-252.

The author analyzes the family labor supply response to an experimental income maintenance program with negative income tax. Two different measures are considered: earnings and family hours worked. Results are presented by ethnic group. Findings show a statistically significant negative experimental-control differential in both total family hours and total family earnings for white and Spanish speakers. Both experimental and control movements were in the same direction -- either both groups increased hours of work but experimentals increased less, or both groups decreased but experimentals decreased more. In general, higher levels of total family earnings were associated with larger negative experimental differentials. This may result from the concentration of families with working wives (who respond more to disincentives) at higher total family earning levels.

Johnson, T.R., and J.H. Pencavel, "Dynamic Hours of Work Functions for Husbands, Wives, and Single Females." Econometrica, Volume 52, Number 2, March 1984, pp. 363-389.

Dynamic hours of work functions are estimated using a sample of almost 1,700 husband-wife families and over 1,300 single females from the Seattle and Denver Income Maintenance Experiments (SIME/DIME). The estimated equations are based on maximization of a Stone-Geary household utility function subject to a budget constraint, where the utility function is determined by a level of consumption and leisure enjoyed by the household in the previous period. Results show that the typical working female displays a positively-inclined hours of work function with respect to her own own wage rates, while most husbands have an hours of work function that is insensitive to their wage rates.

Johnson, W.R., and J. Skinner, "Labor Supply and Marital Separation." The American Economic Review, Volume 76, Number 3, June 1986, pp.455-469.

Evidence from the Michigan Panel Study of Income Dynamics (PSID) suggests that women who subsequently divorce increase their labor supply in the three years prior to separation. A simultaneous model of marital separation and married women's labor supply helps to explain this rise in the female labor force. When they anticipate higher probabilities of separation, results show that women work more (increase their supply of labor) to gain job experience. The model does not reveal any significant effects of labor force participation on divorce probabilities.

Kniesner, Thomas J., "An Indirect Test of Complementarity in a Family Labor Supply Model." Econometrica, Volume 44, Number 4, July 1976, pp. 651-669.

The author derives an indirect test of complementarity to determine the sign of the cross-wage effect in a family model of labor supply. This test does not require accurate estimates of income effects. Sample data is gathered from the National Longitudinal Survey. The sign of the husband's gross labor supply wage parameter varies with whether or not the wife performs market work -- the difference indicates the sign of the compensated cross-price effect. In older persons the nonmarket time of the husband and the nonmarket time of the wife are complementary in consumption.

Levy, Frank, "The Labor Supply of Female Household Heads, or AFDC Work Incentives Don't Work Too Well." The Journal of Human Resources, Volume 14, Number 1, Winter 1979, pp. 76-97.

The author estimates a female labor supply model that requires three simultaneous decisions: a decision on Aid to Families with Dependent Children (AFDC), a decision on labor force participation, and a decision on hours worked. The sample of female household heads comes from the 1968 Panel Study on Income Dynamics. Findings indicate that any AFDC parameter change which increases the program's breakdown income will reduce expected labor supply. Raising the basic level of payments, ceteris paribus, will lower a woman's expected hours of work. The same applies to greater work incentives, including lower tax rates, greater disregards, and a more liberal deductions policy.

Lundberg, Shelly, "The Added Worker Effect." Journal of Labor Economics, Volume 3, Number 1, Part 1, January 1983, pp. 11-37.

The added worker effect -- the temporary increase in the labor supply of married women whose husbands have become

unemployed -- is stated in terms of transition rates rather than traditional static measures of labor supply. Transition rates are estimated using the data from the Seattle ands Denver Income Maintenance Experiments. Results of a household labor supply model (with joint husband/wife employment decisions) show that own wages are important in the decision to enter or leave employment, but that cross-wage effects are insignificant. Simulations of the model verify that the added worker effect for white families (three additional wives in the labor supply for the unemployment of 100 additional men). There is little effect among black families, perhaps because of selection bias.

Mincer, Jacob, "Labor Force Participation of Married Women." In Aspects of Labor Economics, edited by H.G. Lewis, 1962, pp. 63-97.

The author derives the labor supply equation of family members using consumer choice theory and treating the labor supply decision as the symmetrical implication of the demand for leisure. Labor supply as the complement of leisure demand allows direct application of consumer demand theory to the labor supply decision.

Moffitt, Robert, "Profiles of Fertility, Labour Supply and Wages of Married Women: A Complete Life Cycle Model." Review of Economic Studies, Volume 51, Number 2, April 1984, pp. 263-278.

This study takes an econometric approach to female fertility and labour-supply decisions. Based upon utility-maximizing choice, fertility and labour-supply demand functions are specified jointly with a wage-accumulation equation. The author uses a maximum likelihood estimation method that avoids problems of selectivity bias. Results of a life-cycle model show that shifts in the lifetime wage profile are associated with shifts in lifetime profiles of fertility rates and female employment rates. The effect is stronger on employment, although wealth effects on both profiles are small and low in significance.

O'Neill, June, "The Trend in the Male-Female Wage Gap in the United States." Journal of Labor Economics, Volume 3, Number 1, Part 2, January 1985, pp. 91-116.

A substantial difference in wages between men and women has persisted for at least four decades despite the feminist movement, equal opportunity legislation, and an increase in female labor force participation. In terms of hourly earnings, this wage gap was 31% in 1955, 35-37% in the 1960s and 1970s, and back down to 33% in 1982. Initial increases in women's labor force participation were associated with a declining skill level of employed women relative to employed men, where skill is measured by schooling and job tenure. Recently the work experience of

women has been increasing, thereby narrowing the wage gap. Gains by younger women in work expectations, experience, college enrollment and other work-related investments indicate further narrowing of the wage gap in the next decade.

Parsons, Donald O., "Health, Family Structure, and Labor Supply." The American Economic Review, Volume 67, Number 4, September 1977, pp. 703-712.

In an empirical analysis of the labor supply of older men from the National Longitudinal Survey (NLS), Parsons finds a sharp decline of 1300 hours worked per year among individuals with poor health. The decrease is much greater among single men (84 percent of a full employment year) than married men (61 percent), implying that married men are able to use resources of the spouse to augment health. Parsons finds that other income does not effect labor supply but that male labor supply does effect other family income by $0.75 for each hour reduction in work. Most of this increase results from transfer payments. From Productive Americans Survey (PAS) data, Parsons finds that health problems lead to market time withdrawals of 700 hours for the husband and 350 hours for the wife. Spouse illness causes men to increase home production time and women to increase market work time.

Pollak, Robert A., and Michael L. Wachter, "The Relevance of the Household Production Function and Its Implications for the Allocation of Time." Journal of Political Economy, Volume 83, Number 21, April 1975, pp. 255-277.

The authors critique the theory of household behavior based on household production functions, especially as related to the allocation of time. The household production function approach requires constant returns to scale and the absence of joint production. When these conditions are not met, commodity prices depend on household preferences and do not capture constraints faced by the household. If a household exhibits nonconstant returns to scale or joint production, demand functions based on commodity prices are misleading. When production involves inputs of household time, it is likely to exhibit joint production, because the household derives utility or disutility from time devoted to each activity as well as from the output of the commodity. The authors suggest analysis in terms of goods prices instead of commodity prices when technology exhibits either joint production or nonconstant returns to scale.